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ABSTRACT

The Resource Requirements Prediction Model is a computer-based system for generating cost simulations. It was designed to provide a campus planning team with a means to estimate departmental operating budgets required for various levels of enrollment and to simulate changes to budgets resulting from changes in institutional policy. The current model has been in use by colleges and universities since 1973. Since the model may not be appropriate for all institutions, the primer is intended for those who must decide its usefulness in planning in their schools. RRPM's purpose, background, theoretical design, limitations, and uses are discussed, and an organized account of its installation is given. (MSE)

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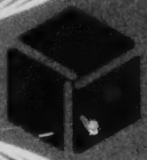
The RRPM Guide: A Primer for Using the NCHEMS Resource Requirements Prediction Model (RRPM 1.6)



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The RRPM Guide: A Primer for Using the NCHEMS Resource Requirements Prediction Model (RRPM 1.6)

NCHEMS Technical Report 104

Gary Gamso

August 1977

The National Center for Higher Education Management Systems
P.O. Drawer P Boulder, Colorado 80302
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Warranty

The software package that constitutes the NCHEMS Resource Requirements Prediction Model (RRPM 1.6) is available through the National Center for Higher Education Management Systems (NCHEMS). NCHEMS certifies that the RRPM 1.6 software meets both conventional ANS COBOL programming standards and the performance characteristics outlined in the *RRPM 1.6 System Documentation.* The Center will notify users of any software problems that are identified and provide the necessary corrections. No other warranty, expressed or implied, is provided with this software.

The RRPM 1.6 software was developed with funding from the National Institute of Education (NIE). For this reason the software is considered in the public domain with no copyright limitations on its duplication or modification. This *RRPM Guide* was also developed through a grant supported by NIE. It reflects the experiences of NCHEMS field support staff that have worked with colleges and universities throughout the country. The opinions and suggestions in this document do not necessarily reflect official positions or policies of the National Institute of Education or NCHEMS.

Preface

This document grew out of a need to provide improved documentation on the NCHEMS Resource Requirements Prediction Model (RRPM). It is based on four years of field experience by NCHEMS staff supporting installation of the model. Until recently, NCHEMS staff have supplemented available documents with federally supported on-site assistance to users of the model, but funding constraints have required the Center to place all on-site assistance on a fee-for-service basis. The *RRPM Guide* is intended to meet at least some of the needs heretofore addressed by the Center's free on-site assistance program.

In the past, NCHEMS staff assistance with software such as RRPM has taken two forms. First, for non-technical users who frequently do not understand information systems concepts or the technical language used to describe them, NCHEMS staff have provided an overview of concepts and their application. The *RRPM Guide* offers both background and overview material for this audience. Second, technical staff responsible for implementing the Resource Requirements Prediction Model generally needed help in organizing for implementation, data collection, data processing, and validation of results. The *RRPM Guide* supplements earlier documentation bearing on these needs, incorporating the experience of staff at NCHEMS and that of the many campuses that have used the model.

This, then, is the document that should be read when a campus first considers using RRPM. It should be read by both administrators and technical staff.

Many more individuals and institutions have contributed to the development, pilot testing, modification, and wide use of the Resource Requirements Prediction Model than there is space here to name. At NCHEMS, key individuals in the development of various versions of the model included Dr. Robert Huff, Dr. Warren Gulko, Michael Young, James Martin, Michael Haight, William Collard, Richard Johnson, Ronald Martin, Charles Thomas, and Dr. Allan Service. The author is permanently indebted to those colleagues who translated an idea into a useful, analytic model and whose professional confidence overcame considerable skepticism and criticism through the years.

Yet the collective skills and diligence of the NCHEMS staff engaged since 1969 in work on RRPM would have borne little fruit without the reinforcing effort and corrective advice of the members of the original RRPM project task force, which devoted some three years to the initial development. More recently, the task force for the NCHEMS Institutional Data Use project furnished a most insightful, critical review of the first draft of this *RRPM Guide*. For all deficiencies arising from imperfect incorporation of their cogent comments and other shortcomings in the document, the author alone is responsible.

Many of the technical suggestions made in this document are the results of first-hand experience at campuses implementing RRPM. Central Oregon Community College in Bend, Oregon, was instrumental in developing and testing many of these ideas. The Center appreciates the contributions made by Dr. Robert Willis, John Smith, and Ron Haggerman of their staff. Special thanks are due to William Johnston and Jean Strueber of the NCHEMS staff for their editorial assistance in the development of the final draft of this guide.

The RRPM Design Task Force (1969-72) included representatives from Humboldt State College, New Mexico Junior College, State University of New York at Stony Brook, University of California at Los Angeles, University of Utah, Stanford University, Portland State University, and Washington State University. The Institutional Data Use Task Force (1975-77) included:

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This document is intended to augment the current documentation on the NCHEMS Resource Requirements Prediction Model. Other documents available from the Center and related to RRPM include:

Introduction to the Resource Requirements Prediction Model 1.6 (Technical Report Number 34A): This document includes a conceptual description of the model's logic and input data requirements.

Resource Requirements Prediction Model 1.6 Reports (Technical Report Number 34B): The document provides a complete set of output reports generated by the model.

Resource Requirements Prediction Model 1.6 System Documentation (Technical Report Number 38): A document for technical-level computer center staff including detailed program documentation and input/output error messages.

Contents

1	Introduction	1
2	Use of Planning Models	15
3	Planning for Implementation	29
4	Data Collection	41
	Appendix	95
	Bibliography	105

Chapter 1
Introduction

The Resource Requirements Prediction Model, one of the first products developed at the National Center for Higher Education Management Systems, is a computer-based system for generating cost simulations. Theory underlying the model began to materialize in the late 1960s, while research was being done on techniques of cost simulation and program budgeting for higher education. The model was designed to provide a campus planning team with a means to estimate departmental operating budgets required for various levels of enrollment. It also could simulate changes to budgets resulting from changes in institutional policy. These capabilities allow the current version of RRPM to produce cost projections that answer questions such as these:

- When enrollments decline (or increase) in a student major, what discipline areas are impacted and to what extent?
- When a new curriculum is designed or an old one deleted, what will be the consequent requirement for full-time equivalent (FTE) faculty and the effect on other costs in each department?
- If faculty salaries are increased by 7.5 percent in selected academic divisions, what will be the attendant bottom-line increase in the instructional budget?

- If an institutional policy to increase the average section size of courses is adopted, what savings can be expected in operating instructional departments?

No computerized planning model can answer such questions with absolute certainty. At best, a model such as RRPM will provide a *rough estimate* of required resources and associated costs—including the number of faculty FTE's, faculty-salary costs by rank, departmental-staff costs, and related operating expenses in each instructional discipline involved.

Following four years of design, pilot tests, and revised versions, RRPM was made available in its current form in 1973. A survey* in 1975 indicated that 128 institutions were in various stages of installing or using the NCHEMS model. Experience at these and other campuses has led NCHEMS to conclude that RRPM isn't the right planning model for every college and university. Some colleges simply don't have the necessary data or would incur an inordinate cost for data collection. Some institutions are developing a comprehensive *planning process,* which includes goal and objective setting, improving the management skills of administrators, annual budgeting, and evaluating the effectiveness of the campus and its units in following a plan. RRPM is not in itself a substitute for such a process. (Later we will discuss the role of RRPM *within* such a process.) On still other campuses, RRPM will not provide the information necessary for planning decisions.

This document is intended for those who must judge whether RRPM is an appropriate planning model for their institution. Such a judgment should take into account at least these questions:

- Does a systematic planning process now exist on the campus, and how might cost projections assist in that process?
- Does RRPM satisfy the cost-projection needs of the planning process?
- Can the necessary data be collected at a reasonable cost?

To facilitate that kind of evaluation, this *Guide* explains the purpose, background, theoretical design, limitations, and uses of RRPM. It also offers an organized account of the technical aspects of installation.

*The survey, done by Dr. Paul Plourde of the University of Massachusetts at Amherst (Plourde 1976), covered 394 campuses known to be utilizing or evaluating planning models.

Definitions

In this document, the term *planning model* is used to refer to a computer-based mathematical model using quantitative data to describe operating relationships in academic settings. A planning model such as RRPM might be called an information system for campus decisionmakers. But RRPM should not be considered a complete management information system, since cost projections are only part of the information needed to support sound planning.

Planning process was defined earlier in terms of goal setting and budgeting, which indeed are fundamental planning elements. A good process crosses organizational boundaries to integrate these elements with respect to three planning areas:

Academic Planning—Developing a mix of academic programs that will serve student needs and best utilize available faculty talent. Planning concerns include (1) program excellence, (2) comprehensive course and program offerings, (3) curricula responsive to student needs, and (4) personnel improvement through faculty development opportunities, pay increases, tenure policies, and such.

Facilities Planning—Building and maintaining an inventory of classrooms, laboratories, and office space.

Financial Planning—Distributing financial resources equitably. Academic and facility planning requirements must be balanced with the need for administrative services, such as libraries, computer centers, and business offices.

An effective planning process depends on cooperative efforts throughout the organization. People in both academic and administrative areas contribute to campuswide planning by agreeing on long-range directions, setting priorities, and accommodating short-range political, financial, or environmental influences. A planning model is only one of the tools available to the planning team.

This document advocates a systematic planning process. Such a process can have the "results" orientation embodied in Management By Objective (MBO) principles, a programmatic focus using Program Planning and Budgeting System (PPBS) concepts, or an evaluation emphasis in line with Zero-Base Budgeting theory. Each of these general managerial approaches, as well as many variations, offers two important advantages to an organization: (1) a reasonably well-documented and therefore understandable rationale for the distribution or redistribution of financial resources, and (2) a decision process based on objective

information. Issues related to the various forms of systematic planning are discussed later in this chapter.

It would be naive to advocate systematic planning without regard for certain collegial realities, such as the need to accommodate faculty-tenure obligations and the need for the managerial process to reflect the styles and preferences of academic administrators. The term *systematic planning* should not imply that allocating resources among academic departments is best done solely on the basis of information about costs or efficiency. Nor should it imply that a campus has absolute freedom to divert people and budgets from one department to another in short order. Instead, systematic planning uses information-gathering tools to anticipate budget shifts that may become necessary, well in advance of the crisis point. It further provides a factual basis for discussions among the decisionmakers who ultimately will be held accountable for any redistribution of resources.

The *RRPM Guide* does not argue, either, that a computer-based planning model is a necessary requisite for systematic planning. A model is simply a helpful aid in gathering and formatting data that describe past operations with reasonable accuracy or that estimate future resource needs.

How and the extent to which RRPM and similar models should be used is a matter of some confusion. At some institutions, a model is considered to be in use once it is being run on a computer. On other campuses, the model is not regarded as being in use unless its reports are being formally employed by administrators. The use of a model can range from the generation of reports that document or analyze cost relationships in various academic departments to the calculation of complicated, formula-based estimates of future resource needs for the whole institution. A continuing problem in the use of RRPM has been a lack of understanding by academic executives of the model's strengths and weaknesses. The following chapter, "Use of Planning Models," provides an overview of RRPM. It is intended to lay a foundation for communication between management decisionmakers and technical staff regarding the characteristics and capabilities of the model and to establish a context for determining how it may be used in planning.

Some Background on Modeling

Academic organizations have various reasons for using planning models and developing information systems. In most cases, two reasons are fundamental:

1. **A reaction to immediate or expected financial exigency:** When immediate

cuts in institutional budgets are necessary, information systems are occasionally used to justify what are essentially political decisions. A more positive utilization for such systems is as an aid in monitoring campus operations and a contributor to more informed decisions.

2. **Complete a comprehensive Management Information System (MIS):** An MIS generally is developed in a layered, or hierarchical, manner. Early stages of development concentrate on supporting day-to-day operations such as payroll, accounting, and student records. In later stages of development, a planning model uses day-to-day operational data as a basis for cost projections.

Whether the motive for developing a planning model is to cope with financial pressure or to complete a comprehensive MIS, generally a clear and specific purpose is in mind. Nonetheless, the currency of misinformation about computer-based systems often arouses false expectations in potential users, with concomitant frustration in the near offing. It is well, then, to consider these purposes and expectations in some detail.

In recent years, declining or stabilizing enrollments and increased emphasis on fiscal accountability have motivated many colleges and universities to develop or acquire a planning model. Business or planning officers have seen models as potentially useful in meeting their dual responsibility—to equitably redistribute resources in response to variance in enrollment levels or shifts in student demand, and to document a campus master plan and its attendant resource requirements. These activities quickly impact academic goals and fiscal policy.

However disparate, development of a master plan and fluctuating enrollment both cause redistribution of resources among academic departments and thereby promote institutional change. As administrators search for new and better alternative uses of resources in hand and also seek to project future needs, mathematical planning models are coming of age. Out of years of experience in the design and application of planning models, Tom Mason (1976) of the University of Colorado has observed:

> The use of computer models as a tool for planning, management, and policy making in postsecondary education seems to be reaching the mature young adult stage. After about twenty-five years of development; about fifteen years of youthful and energetic experimentation; about five years of increasingly hard knocks, criticism, failure to win; and (we hope) a growing realization of how to live in this old but constantly new (changing) world . . . computer

modeling shows promise of producing more usable and useful assistance to the managers of higher education.

Planning models have been developed as part of several new management processes. They include:

Formula Budgeting—Using a mathematical formula to translate some measure of inputs, such as student enrollment, into operational data, such as the number of FTE faculty. To date, formulas have been used mainly at the state level. They are used more frequently in compiling budget requests than in making actual budget allocations. At many institutions, planning models use mathematical formulas to derive faculty, staff, and operating expenses from the number of students enrolled and past course-taking patterns. Again, because of their dependence on quantitative data, these formulas and models are generally used in preliminary rather than final budget stages.

Program Planning and Budgeting—This system has as its primary information focus institutional programs such as instruction, research, public service, or the student major. Evaluation of campus operations considers the resources used and outcomes produced by these programs.* Budgeting, however, usually is done along the traditional organizational lines. A planning model such as RRPM prepares a budget estimate in both program and unit format.

Management By Objective (also known as "results" management)—This approach depends on a clear statement of campus mission and short-range goals. Organizational units are then accountable for their annual results within a framework of negotiated unit objectives.

Zero-Base Budgeting—Unlike most other techniques, this system combines many aspects of annual evaluation and budgeting. Each organizational unit is required to justify its existence annually. A budget submission justifies all funds requested, not merely an incremental change in the previous year's budget base.

In its own way, each of these management processes requires a periodic reevaluation of the institution's purpose and goals and the contribution each organizational unit makes toward the accomplishment of these goals. Each process relies on objective information documenting historical campus operations and all emphasize planning.

Most new management techniques and their informational supports are products of a growth era for higher education, when management was mainly

*One of the big problems with PPBS is the measurement of program output. See Micek and Wallhaus (1973).

concerned with the equitable distribution of *new* resources in the campus budget. To function effectively, they all require a substantial investment in time and resources as well as a willingness on the part of management to accept new ideas and adopt innovations. The new management processes all are driven by the involvement of people: information is a resource to use in monitoring past operations or to better estimate future activities.

Planning models can provide simple, roughly derived information for planning or more sophisticated budget-formula calculations. In either case, the information does not supplant the judgmental component in decisionmaking. Used properly, information provides an early warning system by identifying potential problem areas. Early planning-model designers suggested that they could provide a panacea for the tasks of allocating resources or demonstrating to outside funders a need for a larger resource base. Users of planning models quickly discovered, however, that resource allocation and budgeting are the responsibility of individuals and that a planning model is only an aid in looking at alternative allocations. They learned, too, that the need for increased resources can be demonstrated to funding agencies with mountains of supporting computer printout, but institutions nonetheless often receive less financial support than requested. Here the planning model proves to have a saving grace: if the information it provides for funding requests is less than totally effective, it yet can be helpful in examining alternative ways of adjusting to the lower funding level.

Investments in computer equipment and labor to develop planning models and information systems generally result in a more uniform, timely, accurate, formal—and more rigid—flow of information throughout the campus. It has been convenient for the developers of information systems and models to indict campus executives for resisting change in the operating status quo or for failing to use effectively all the data available from information systems. The fact is that there are serious and justified criticisms of the systems approach to management. Hefferlin and Phillips (1971) say:

> We believe that the fact channels of information useful for determining and carrying out policy in higher education are both overburdened and underdeveloped. . . . most informal communication channels are unavoidably parochial, and most formal channels are so unnecessarily impersonal as to be unresponsive. Talk is constrained; print is rampant.

From correspondence with presidents and deans, they discovered that an executive's worst difficulty is not the lack of useful information, but rather the

oppression of useless data. Kirschling (1976) lists the common mistakes of model builders—claiming to be able to do too much, creating the appearance of certainty, using inappropriate techniques, and being technique-oriented rather than problem-oriented. He goes on to cite a more serious blunder—the failure of management users and model builders to cooperatively (and openly) develop a model that is theoretically sound, conceptually simple, and yet practical. These criticisms don't suggest that computer systems and planning models are inappropriate so much as that the designers somehow should do more to meet the needs of management users.

Early attempts to use modeling in educational administration experienced limited success. Experience at Yale University documented by Geoffrey Lockwood (1972) suggests that models and information systems—

1. increase organizational stress as they provide more information on internal operations to more people, thereby subjecting managers and their decisions to widespread scrutiny;
2. demonstrate the absolute imperative for senior management to be information-oriented before the institution undertakes the development of information systems;
3. cost a great deal in time, labor, and capital; and
4. frequently are not matched with any other significant management innovations.

Roger Schroeder (1977) maintains that effective management systems can be developed for colleges and universities if the correct assumptions are made about system capabilities and administrative needs and if the developmental process is well defined. He recommends a set of broad assumptions to use as guidelines for the development of management systems such as management by objective. His assumptions apply equally well, however, to supporting information systems and planning models. Here is a brief summary of the assumptions Schroeder recommends:

- A management system that readily provides comprehensive information for all conceivable management decisions is impossible to attain. It is more realistic, then, to consider the development of systematic information flow, supported perhaps by computer-based systems, in company with less structured staff capability to perform policy analysis. Many policy problems therefore would be dealt with ad hoc.

- Identification of information needs is facilitated by interaction between management user and technical analyst. Whatever system is considered, both must be involved in specifying the objectives, identifying constraints or assumptions imposed by the system, outlining the alternatives to be studied, and estimating the time or resources required. Any system proposal should specify a thorough examination of the existing system, to document relevant parts and relationships to existing management processes.
- Vendors, promoting generalized systems such as RRPM, should encourage institutions to carefully define their information needs, including the possibility of developing their own system. Common difficulties in using generalized systems: (1) none of the available vendor systems may fit an institution's needs, (2) the system installation process doesn't include an effort to improve the decision process itself, (3) installation of the system becomes an end in itself, and (4) the user's involvement is usually insufficient to assure that the information will be used after it is produced.

The technical capabilities of a planning model are only a partial determinant of its ultimate success. At least of equal importance is its utility to those who ultimately use it. When administrators are asked, they understandably cannot describe all their present and future informational needs. While they possess the technical skills for developing the means, systems analysts and vendors are even less qualified to identify these ends. The more successful ventures in developing management information systems combine the talents of technicians and management users in a cooperative effort with shared responsibility.

A Survey of Generalized Planning Models

In essence, planning models are abstract, quantified representations of the real world. In postsecondary education, they represent an attempt to abstractly simulate, in pictorial, physical, or mathematical terms, a particular process or function (Gaunt and Haight 1977) existing in the educational enterprise. Instruction is a process that is particularly quantifiable and for which a large amount of operating data is usually available. Recently developed planning models are categorized as *enrollment-driven* models; they simulate the instructional interaction between faculty and students. That is, as the number of students increases or decreases, the varying demands for courses in each department directly influence the number of instructional resources required in that department. Departmental

resources such as instructional faculty are thus determined by student enrollments and the manner in which they take courses. For example, an enrollment-driven planning model requires as input an estimate of the number of students enrolled in each major and the courses typically taken by those majors. From these data, the model projects the number of courses that each department should offer and the resulting faculty, staff, and operating-expense requirements within the department.

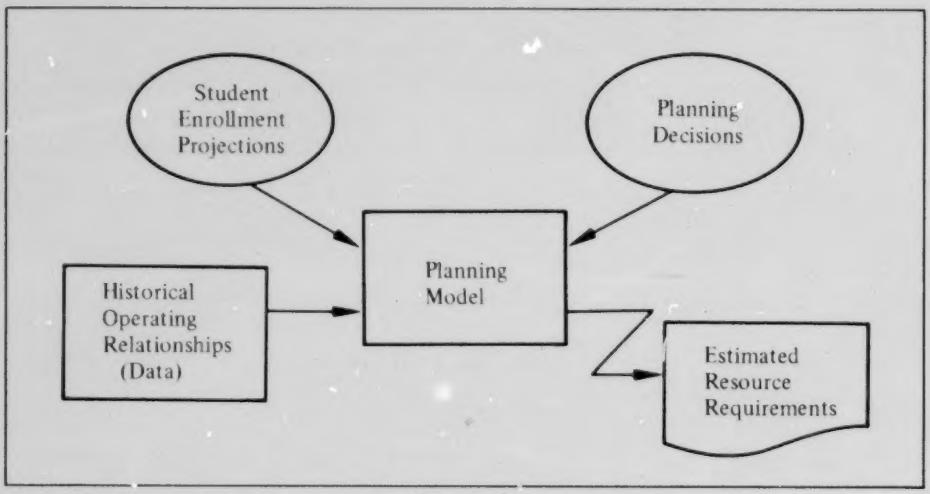
Early work in resource modeling was done in the mid 1960s, when Dr. George Weathersby, then a graduate student at the University of California at Berkeley, designed a cost-simulation model for universities. The primary basis for this model was development of a set of vectors that represented the instructional demand or load that would be placed on the institution. The concept expressed in the Induced Course Load Matrix (ICLM)*, or student-preference matrix, has already been developed by Suslow (1965), but was further refined and implemented in Weathersby's model (Springer 1977). The Resource Requirements Prediction Model (RRPM) was developed using Weathersby's earlier work. Later, Weathersby (1972) provided a comparison of the structural differences in generalized models developed using his earlier conceptual work.

The *generalized models* are similar in concept, as illustrated in figure 1. (Generalized models are defined by Gaunt and Haight [1977] as comprehensive models intended to be applicable to all major types of institutions.) Historical relationships are derived through analysis of past campus operations to produce *average* course-taking patterns (the ICLM) and parametric data on faculty, staff, and operating expenses. The enrollment projections shown in the figure are provided as input to most such models. They are used to simulate the total demand for instructional courses or credit hours, and from this to estimate the resources, such as faculty, staff, facilities, and operating expenses, necessary to provide these credit hours. With simulation models, a series of *what if?* questions can be asked in considering planning decisions or alternatives. The questions will concern such things as changes in faculty workloads, faculty/staff salaries, and parameters affecting departmental expenses; increases, decreases, or shifts in student enrollments among majors; and shifts in course-taking patterns.

The various generalized planning models now available differ in two fundamental respects: (1) the level of detail of input/output in the model, and (2)

*The Induced Course Load Matrix (ICLM) is a two-dimensional matrix used to define the historical credit-hour load placed on academic departments by each student major. It will be further described in a later section.

Figure 1
Generalized Planning Models



comprehensiveness. The more detailed models estimate resources by course and section and deal with various categories of resources, such as faculty, staff, expenditure items, and facilities. The more aggregate models produce results at a higher level of summary. A model's comprehensiveness is determined by the organizational functions that it includes. Models such as RRPM are primarily designed to estimate resources used in instruction. Others include departmental research and administrative services, such as libraries, deans, business operations, and physical plant.

Model builders generally agree that selection of a model depends on the detail and comprehensiveness needed by its potential users, the detail available in campus data systems, the types of planning questions to be asked, and the cost of purchasing and developing the model, collecting data, and operating it. As more detailed and comprehensive planning models come into use, significantly more time is required to collect and process data. Moreover, results are more sensitive to inaccuracies in input data, and the logic employed by the model is more difficult for the user to understand.

A few generalized planning models are available today through various organizations. A campus has the alternative of developing its own planning model or using a generalized one. The major advantage of an institutionally developed model is that it may more closely represent actual campus operating patterns. A generalized model has the advantage of providing a fairly close approximation of operating patterns at what is generally a substantial savings in software development cost. Some of the most widely used generalized planning models identified by Plourde (1976) included: RRPM, available from NCHEMS; the Comprehensive Analytical Methods for Planning in University/College Systems (CAMPUS), produced by Systems Dimensions Limited (SDL) of Canada; the Higher Education Long-Range Planning/Planning Translator (HELP/PLANTRAN), supported by Midwest Research Institute (MRI); and the System for Evaluating Alternative Resource Commitments in Higher Education (SEARCH), available through Peat, Marwick, Mitchell, and Co. The main purpose of Plourde's study was to identify the reasons why an analytical model should be selected, problems and successes of implementation, user perceptions of usefulness of the model chosen, and user views on the value of models for planning and decisionmaking in higher education.

These are the characteristics of the three most commonly used models:

RRPM—A mathematical model with a fixed design. That is, operational relationships are a permanent part of the model's design. For example, from enrollment projections, the number of students taking English courses is estimated; using average student/faculty ratios in English, the number of courses determines the number of English faculty required. Input data such as a student-faculty ratio define the magnitude of each relationship. With a fixed design, however, the model proceeds from an enrollment projection to estimating the faculty and staff requirements and associated expenses. RRPM is primarily instructional and does not accommodate revenue data.

CAMPUS—A mathematical model with a fixed design, similar to RRPM. It is generally recognized to be more detailed and more comprehensive than RRPM. While RRPM estimates the number of faculty required to teach English courses, CAMPUS estimates the number of course sections to be taught: such detail requires more input data. CAMPUS also includes a component that estimates facilities requirements, while RRPM does not.

HELP/PLANTRAN—Not a fixed-design model. Each user defines the operating relationships and data needs relevant to a specific planning question. This model is used initially for rather generalized policy analysis. But as the user's experience with the model grows, it can be used in more complex ways. It can be designed to include cost/revenue analysis. RRPM and CAMPUS are generally thought of as cost-simulation models.

Other generalized planning models are available. The bibliography includes references to models mentioned earlier in this section, but not discussed above. Gaunt and Haight provide further information, from a nontechnical perspective, on the various approaches to planning models and the variety of generalized models that are available. Other commentaries on the background and concepts of computer-based models are provided by Sheehan/Gulko, Farmer, Lawrence/Service, Plourde, Wartgow, Hopkins, Keane/Daniel, Midwest Research Institute, and Clark.

Chapter 2
Use of Planning Models

In a recent thesis on the use of a planning model in a steady-state environment, Colby Springer (1977) suggested that three developments have led to increasing use of models in recent years:

1. The nature of decisionmakers: there are now a number of quantitatively oriented administrators in higher education. This fact is due to the emphasis of scientific training that graduates of the high technology period of the 60s have brought with them; the increased use of data processing in higher education that has further provided the tools by which quantitative approaches are made feasible; and the availability of inservice training that has broadened the acceptability of modeling.
2. Increasing financial and enrollment pressures on institutions have laid emphasis on the planning function, particularly the planning of facilities and faculty.
3. Several widely used generalized models (those mentioned earlier in this document) are now available for implementation.

Experience of NCHEMS staff over the past few years indicates that although the state of the science has advanced significantly, the use of planning models in

colleges and universities remains limited. There certainly is no single formula for successful adoption and use of planning models. But those institutions that have been successful have had at least the following common elements in their efforts: (1) they have recognized that models are not yet able to *perfectly* represent all the complexity and diversity of the educational enterprise, and have been willing to accept a less-than-perfect solution; (2) they have chosen a model that meets the needs of their particular campus planners, matching the management styles or techniques employed; (3) they have used an internal training program to help administrators become more *information-oriented* and to increase their awareness of the assumptions, generalizations, and abstractions that are part of the planning model.

This section describes the role of a model such as RRPM in a conceptual planning framework, discusses the capabilities and limitations of RRPM, and outlines a few exemplary uses of the model. When discussing use, it is important to recognize that the output generated by any planning model is properly used only when it serves as input to, but does not dominate, the decisionmaking process (Gaunt 1977). Resource estimates and attendant costs are not the only factors to be considered in financial decisionmaking, and analytic data alone do not determine institutional plans. (Future work at NCHEMS will document various strategies for decisionmaking in the areas of resource evaluation, allocation, and planning.)

A Planning Framework

The RRPM is designed to support most of the planning and management techniques outlined earlier (MBO, PPBS, Formula Budgeting, and so forth). It is intended to help formulate or display both long- and short-range plans for use of resources by the campus. The model should be integrated into the existing system for campus planning; it is not a planning system or a planning cycle in itself.

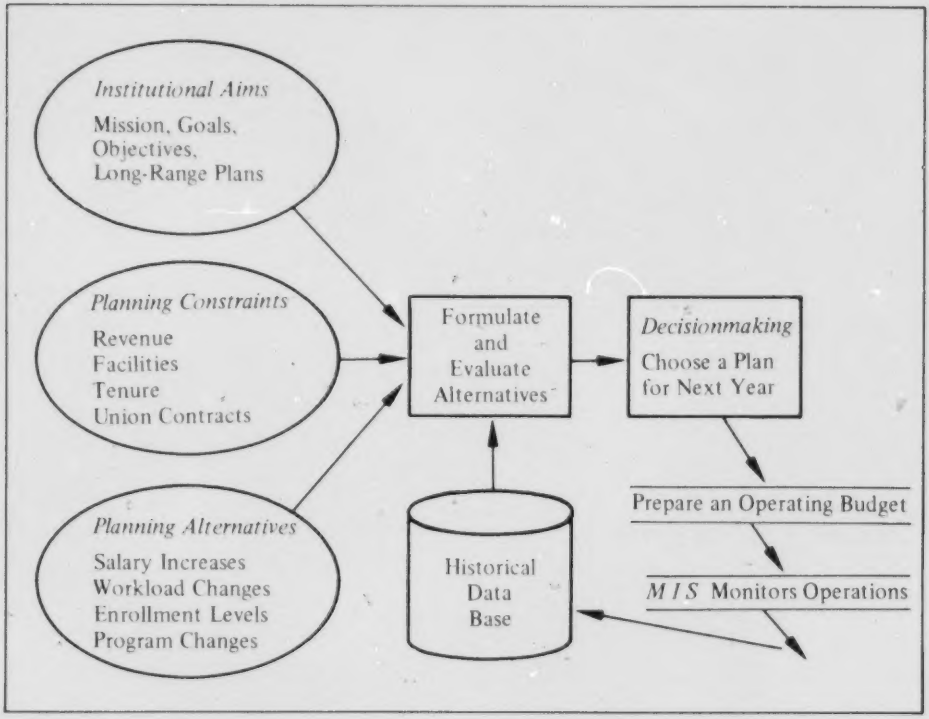
A formal planning *process* can be a valuable asset. It can help the institution progress in ways that its trustees, officers, faculty, and students consider most suitable; it can provide a process for institutional response to challenges in the environment; it can present various available alternatives. It can become a vehicle for response to strengths and weaknesses; and it can focus on utilization of resources to best advantage (NACUBO 1975). Long-range planning tries to broadly define the characteristics that the institution should develop over the coming three

to eight years. Short-range plans or budgets are attempts to direct activities toward the desired long-range results.

Figure 2 illustrates a general framework for short-range planning. Most of the activities center on the formulation and evaluation of alternatives.

Any alternative plans must be consistent with the institution's *purpose*, described in statements of mission, goals, and objectives, and long-range plans. In a similar planning cycle developed by NACUBO (1974,a), *mission* refers to the broad, overall, long-term purpose of the institution; *goal* implies something more definitive and capable of achievement in a certain period of time; *objective*

Figure 2
A Simplified Planning Cycle



represents a tangible statement for which progress can be measured over a short period, such as a budget cycle.

Each planning system must be capable of operating in the presence of either real or expected *planning constraints*. Since there always is some limit to expected financial resources, some levels of services or programs must be chosen to the exclusion of others. Again, these choices should be consistent with preferred long-term directions. Available facilities, faculty tenure, and union contractual obligations must also be considered as planning constraints. These are not necessarily undesirable, but they are realities that must be considered in any planning.

The institutional planner not only must live in a constrained environment, but also must consider certain *planning alternatives* that would alter the college's operations in the coming year. Such alternatives might concern salary increases for faculty and staff, changes to personnel workloads, shifts in enrollments among student majors, and the addition or deletion of new curriculum offerings, with their attendant start-up or phase-out costs. A planning model can make rough estimates of resources and costs associated with the various alternatives to be considered. The model also can be instrumental in roughly defining limits for deans and departmental chairmen to use in their preparation of initial budget requests. A model such as RRPM can be helpful later in estimating the resource impact of departmental budget requests at various enrollment levels. RRPM does not have the ability to consider the mission, goals, objectives, or planning constraints, such as revenues and facilities in the evaluation of alternatives. These and a host of nonquantifiable and usually political aspects in the selection of a single plan for the next operating period must be taken into account during the decision process. The operating budget in figure 2 translates the academic plan into fiscal terms.

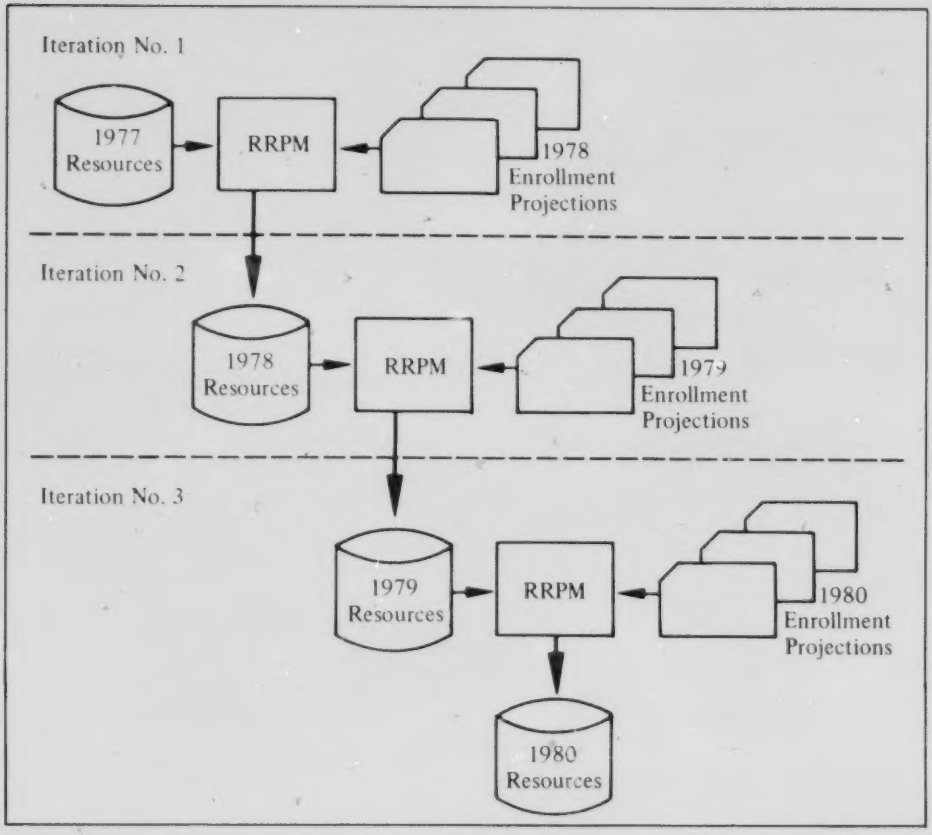
Figure 2 also illustrates that a Management Information System (MIS) monitors financial expenditure patterns and other campus operations to report the cost of operations throughout the budget period. Just as important, an MIS can be instrumental in developing parameters that describe the historical patterns of operation. In turn, this information becomes input to a planning model to support simulations in the next planning cycle.

Within this general planning framework, a planning model cannot provide precisely accurate resource projections. At best, what can be reasonably expected are rough, expedient extrapolations of past operations, reflecting planning changes. With regard to any particular alternative, a model is commonly used to estimate

resource requirements in both the most and least ideal set of circumstances. This identifies the boundaries for decisionmaking.

RRPM is also useful in long-range planning efforts. Data developed for a past period can serve as the basis for iterations of estimates of resource needs over a series of years. For example, in figure 3, the 1977 operating data are used to develop input parameters for a base year, from which a simulation is performed.

Figure 3
RRPM Long-Range Estimates



Using the 1977 base-year parameters and the 1978 enrollment estimates, the model produces an estimate of 1978 resource requirements. This estimate then becomes the base data for 1979 estimates, and so on. For each iteration, additional parameters can be provided as input to the model to modify the base-year data so that it will provide for such things as salary increases.

It should be kept in mind that the model is best used in the identification or formatting of alternatives, rather than in the selection of a presumably best alternative, which involves consideration of constraints and nonquantifiable factors that are beyond the scope of most models. Also, because RRPM uses average historical data, it cannot provide exact estimates of short- or long-range future operations. Effective use of the model depends on an understanding of its strengths, weaknesses, and incorporated assumptions.

RRPM Concepts and Assumptions

A conceptual description of the model is provided in appendix A. A more detailed description of RRPM input data and computations is provided by Clark and others (1973). The remainder of this discussion assumes that the reader is generally familiar with the model and its computations. Here is a summary of the model's capabilities and limitations:

Scope: RRPM is designed to estimate instructional resources and their related costs. The model will not estimate any facilities requirements and will not project revenues. Because it is primarily an instructionally based model, its ability to estimate resources for noninstructional activities is limited. These include departmental research and public service that take place in academic departments as well as administrative services—libraries, physical plant, financial aid, and so forth. Each can be approximated with estimating equations that represent the activity as a function of an instructional parameter, such as full-time equivalent (FTE) faculty, credit hours, and instructional support staff. For example, departmental research might represent 25 percent of a typical faculty member's workload. A formula might be developed to indicate that for every .75 FTE instructional faculty, there is a .25 FTE faculty used for departmental research. If an activity like departmental research is *not* closely tied to an instructional parameter, the model is less useful in estimating these resource needs.

Technical Support for Data Collection: Earlier versions of RRPM were more detailed and comprehensive. The current version has been simplified to reduce

data-collection requirements and to facilitate understanding of the model's computations and assumptions. In addition, NCHEMS has produced a Costing and Data Management System (CADMS) to provide software support for the formatting of historical input parameters for RRPM. (Chapter 4 describes the use of this software in preparing RRPM input data.)

Optional Computation Method: The current version of the model will accommodate either a relatively simple *short method* for estimating FTE instructional faculty, based on total credit hours required of a department, or a more complex *long method.*

The *short method* requires an input parameter known as a productivity ratio, which is similar to a student/faculty ratio. The *long method* for calculating FTE faculty includes allowances for separate types of instruction (lecture, lab, team teaching), average section sizes, and faculty-contact-hour workloads. For each academic department, the model user must decide whether short- or long-method data are to be collected. Long-method data, though more difficult to collect, do make it possible to simulate micro changes in departmental parameters, such as a 10 percent change to average section size for a given department.

Computer Precision: RRPM and other computer-based models offer a false sense of security because of the two-decimal-place precision used in reporting of resource estimates. Although the model is penny-precise, this should not be misinterpreted as an absolutely accurate representation of the actual resources required by the institution. Interpretation of results should always recognize that the model produces *estimates* of future resource needs.

Using Average Parameters: Most input data for RRPM are in the form of averages. This in itself contributes to some inaccuracies in results because of computational rounding. The Induced Course Load Matrix (ICLM), for example, represents the average course-taking pattern for each type of student major. Inaccuracies in maintaining student-major data can result in an ICLM that does not accurately reflect the course-taking patterns of each student major.

Fixed, Variable, and Semivariable Cost Relationships: In "Fundamental Considerations for Determining Cost Information in Higher Education" (NACUBO 1974,b), the concepts of *fixed, variable,* and *semivariable* costs are explained. These costing concepts can be used to describe some of the assumptions built into RRPM. *Variable costs* fluctuate in direct proportion to the volume of units of service provided. The cost associated with FTE faculty in RRPM can be considered variable, where the units of service are credit hours

produced by a department. Figure 4 illustrates this relationship when a simplified formula (short-method computation) is used to estimate FTE faculty. In the diagram, as in the model, a constant credit-hour-to-FTE-faculty ratio is used to define this relationship: as the number of credit hours taught in a department approaches zero, so does the number of FTE faculty.

In practice, of course, faculty are not completely a variable expense. Because of faculty tenure, there usually will be a minimum level of faculty in each department regardless of the teaching load, in keeping with institutional policy or contractual agreements. This minimum level is the *fixed cost*—a cost that remains constant over a period, regardless of the number of units of service (credit hours) provided. The cost of the department chairmanship might be considered a fixed cost.

Figure 5 illustrates the minimum levels of FTE faculty that result as the department's credit-hour production is reduced toward zero. The diagram further illustrates the *step-function* relationship traditionally used in budgeting and operating academic departments: a new faculty FTE position is allocated to the department only after a significant increase in the number of course sections or credit hours to be offered by the department. This step function is known as a *semivariable cost,* which includes both fixed and variable components.

Figure 4
RRPM Short-method FTE-Faculty Estimation

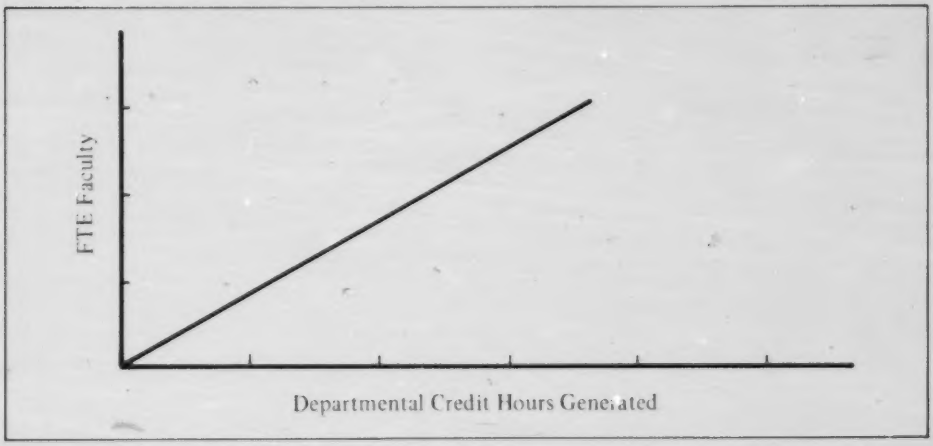
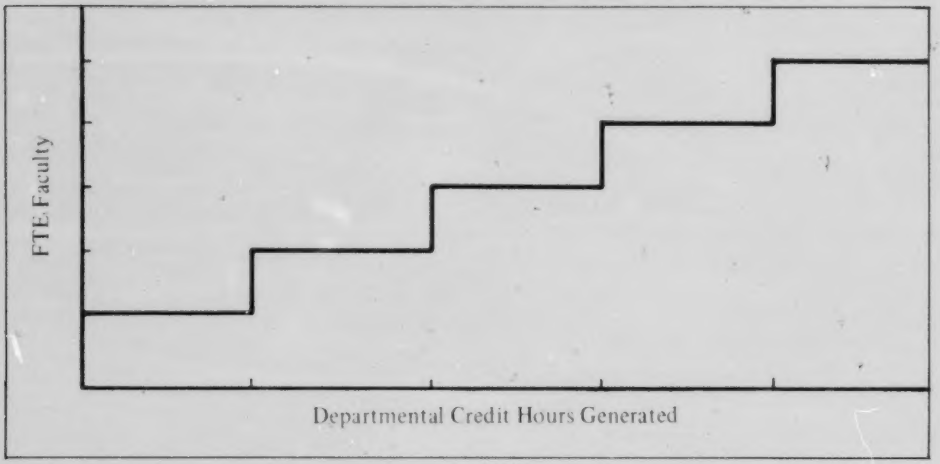


Figure 5
Actual FTE-Faculty Estimates

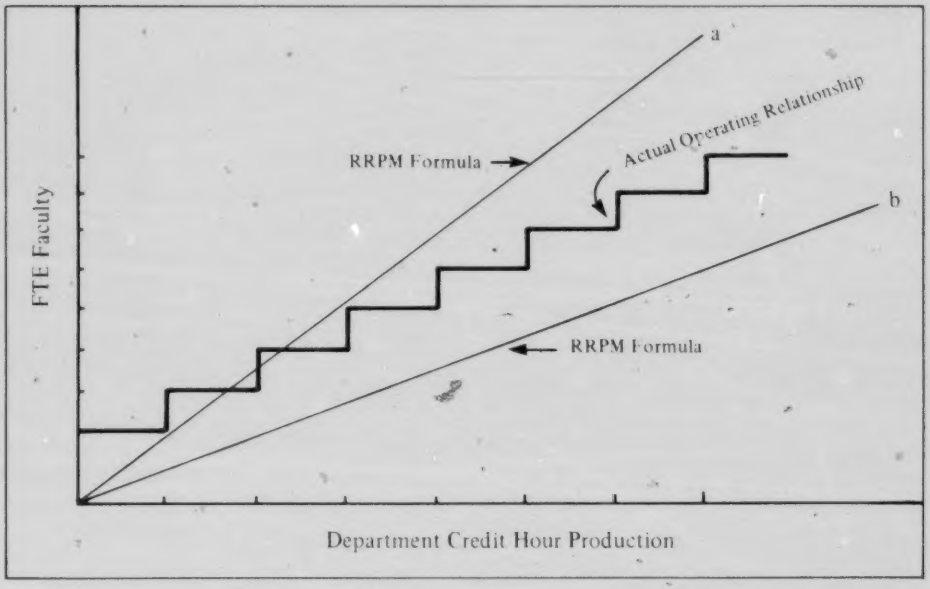


Considering FTE faculty as a variable cost in RRPM is done to simplify both the collection of historical data and the understanding of the model's logic. Actual use of the model by institutions is better illustrated in figure 6. In the diagram, lines a and b represent the linear estimations of FTE faculty under the most ideal (a) and the least ideal (b) cases of faculty workloads. These two simulations by RRPM will effectively bracket the step function that approximates departmental operation. Multiple estimations help to define some of the planning limits within which the campus can develop a single plan that considers both the quantifiable and nonquantifiable objectives of academic departments.

The expenses for departmental support staff and nonpersonnel ties, such as supplies, equipment, and services, are also represented in the model as formulas. (Chapter 4 fully describes these formulas.) A simplified version of a formula for determining the number of departmental secretaries is shown in figure 7. The formula for secretaries assumes that, essentially, they are directly related to the number of FTE faculty. Again, the formula is semivariable, with fixed and variable components.

Thus far, the discussion of fixed, variable, and semivariable costs has applied to the input data and internal computations. The notion of *unit cost* also is used

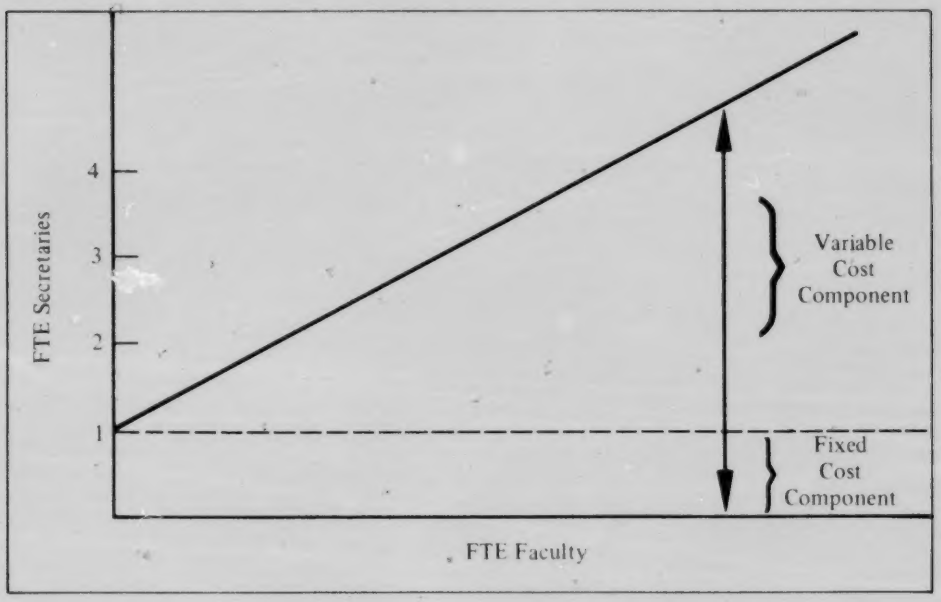
Figure 6
Best- and Worst-Case Estimations



in the outputs generated by the model. With respect to RRPM, unit cost means the estimated average cost to teach a credit hour in a department for the period being simulated. Thus the cost figure is the sum of fixed and variable costs in the department divided by the total credit hours produced. It should not be confused with *marginal* or *incremental* cost—that is, the cost of teaching one additional student or course.

A Planning Model Can Perpetuate Inequitable Resource Patterns: As we have seen, historical data are the basis for cost simulations produced by RRPM and other planning models. A common concern among model users is not only the inaccuracies involved in collecting historical averages, but also the fact that when inequities in workload patterns or salary rates exist, they become part of the historical data. The model thus projects these inequities into future operating periods. Data preparation and validation of the model will produce average

Figure 7
Departmental Secretaries Formula
FTE Secretaries = 1 + 1/4 (FTE Faculty)



profiles of the workload patterns and salary rates for faculty and staff. These data can be useful in documenting the differences in workloads, salaries, and expenditure patterns throughout the instructional discipline for the institution. Once the differences are understood, the model can be instrumental in simulating the effect of changing these historical patterns.

RRPM Cost and Benefit: The RRPM can substantially reduce investment in staff and time required to design, develop, and test a planning model. This savings comes with a few tradeoffs, however. First, the institution is forced to accept the RRPM design, assumptions, and limitations. Second, there still must be a substantial investment of staff time and computer resources in collecting and processing data to prepare RRPM inputs. This, however, is true for either a generalized model or one developed by a campus to suit its specific needs. Third, skills must be developed among technical staff, and administrative users

also must be trained. For the most part, the training can be done without outside assistance. Nonetheless, it is an implementation cost.

One of the most important features in RRPM is its generalized design. Most home-grown planning models are designed to reflect the established data conventions and organizations of the institution. While this is a good short-term approach to design, changes such as the addition of new student majors or disciplines would require expensive software modifications to a tailored planning model, unique to one campus. With RRPM, this type of organizational structure is provided through input data so that a new major would require only a new input data item and no software changes. There are limits, however, to the number of variables, such as majors, the model can accommodate (see chapter 3). Also, RRPM will produce multiple simulations at various levels of detail simply by redefining input data. For example, a simulation might be produced that estimates resources for a discipline at the following level of detail:

a. Faculty Ranks: Professor
Assistant Professor
Associate Professor
Instructor
Part-time instructor

b. Course Levels: Lower Division
Upper Division
Graduate—Master's
Graduate—Doctorate

The software used to prepare RRPM input parameters can summarize the data for a subsequent simulation with the following level of detail for resource estimates:

a. Faculty Ranks: Full-time
Part-time

b. Course Levels: Undergraduate
Graduate

(This capability to vary the level of detail used in the model is further discussed in chapter 3.)

Finally, an important factor in considering whether to employ RRPM is to ensure the model can accommodate the exceptional aspects of campus operations.

By their very nature, planning models represent simplified abstractions of the real world. No model exists that exactly replicates the operations of a particular campus. The best that can be expected is a near fit.

Sample Uses

In 1974, NCHEMS published *Profiles of Management Information Uses* (Huff and Young). This document provides brief accounts of the application of RRPM and other NCHEMS software in management information systems used to support planning and management decisions on twelve different campuses. Here, in gist, are some of the user experiences described in the *Profiles* document:

- RRPM was used to provide the campus executives on a state university campus with aggregate information to aid in setting broad tenure guidelines, workload targets, and funding patterns for each academic division. The information (not the model) was instrumental in moving many of the micro decisions related to awarding tenure and allocating departmental resources to the level of divisional deans, thereby making them more effective in managing their own resources.
- A community college involved in union contract negotiations found the RRPM software useful in simulating the financial impact of many of the anticipated bargaining demands related to workloads, salaries, fringe benefits, and so forth. It was helpful not only in assessing the immediate budgetary impact but also the longer range impact of trends the bargaining demands would set in motion. The model served both sides of the negotiations by providing a reasonably objective means for simulating the changes to certain parameters.
- In a private college, the Vice-President for Academic Affairs has found the model a useful aid in making staffing decisions related to the appointment of new faculty and to the reassignment of personnel within academic departments. He found the model less useful in selecting the right decision than in simulating workload patterns and costs at various staffing levels.
- A number of campuses found the model useful in presenting instructional cost projections to funding agencies in the traditional discipline "line-item" format or in program budget format. The data used in such presentations was generally more aggregate than that used by the campus but still facilitated an explanation of the components of discipline and program costs.

- A large state university found the projected cost and unit cost data an important part of their program review efforts. It is important to note that the process involved a review of many more aspects of each student major program than its costs. It was helpful, however, to have objective, compatible cost data to use in the review process.

Other efforts are being made at NCHEMS to document in more detail the various strategies used by colleges and universities in successful RRPM implementation. The first of these case studies will be available in late 1977.*

*For information about NCHEMS documents and other products, write NCHEMS Publications, P.O. Drawer P, Boulder, Colo. 80302.

Chapter 3
Planning for Implementation

A decision to install a planning model such as RRPM should rest on due consideration of the design, assumptions, and limitations of the model as well as the institution's information needs and the alternative ways in which these needs may be met. That decision having been taken, the next step is to develop a plan for installing and making use of the model to support campus planning. It is a common complaint that the intended users of computer-based models are confused about what final product to expect, that they frequently are given unrealistic estimates of the time needed to install the model, and that when they finally receive information from the model, it is too late to make use of it in the decision process. When the installation of RRPM or a similar model is planned, the administrators who ultimately will use the information should be accurately informed about how much time will be required, what user training will involve, and should have a voice in the many of the implementation decisions. Successful implementation will see the model serving a significant support role or providing a focus for planning operations. Such success will depend in large measure on how familiar its users become with the model. From the outset, therefore, administrators should be oriented to the purpose of RRPM and also to the cost and difficulty of collecting, formatting, and processing data.

Implementation Strategies

The intended use of the model should be the major determinant of implementation strategies. If it will serve one administrative unit, such as the planning office, for a single function, such as long-range planning, most of the implementation decisions can be made in the planning office. But where the model is intended to provide information that will help instructional deans or department chairmen to prepare request budgets, this larger audience should be involved in such implementation decisions as the level of detail (or aggregation) specified for data, or the time frame for distribution of results. A model being considered for wide-scale use might first be tested or evaluated by one office, such as planning or institutional research, or a by a few deans or department chairmen. In this way, many implementation decisions can be made by a relatively small number of users at the outset. Later, when more people are involved in implementation, they often will be reacting to (or challenging) previous decisions rather than trying to reach large-group consensus.

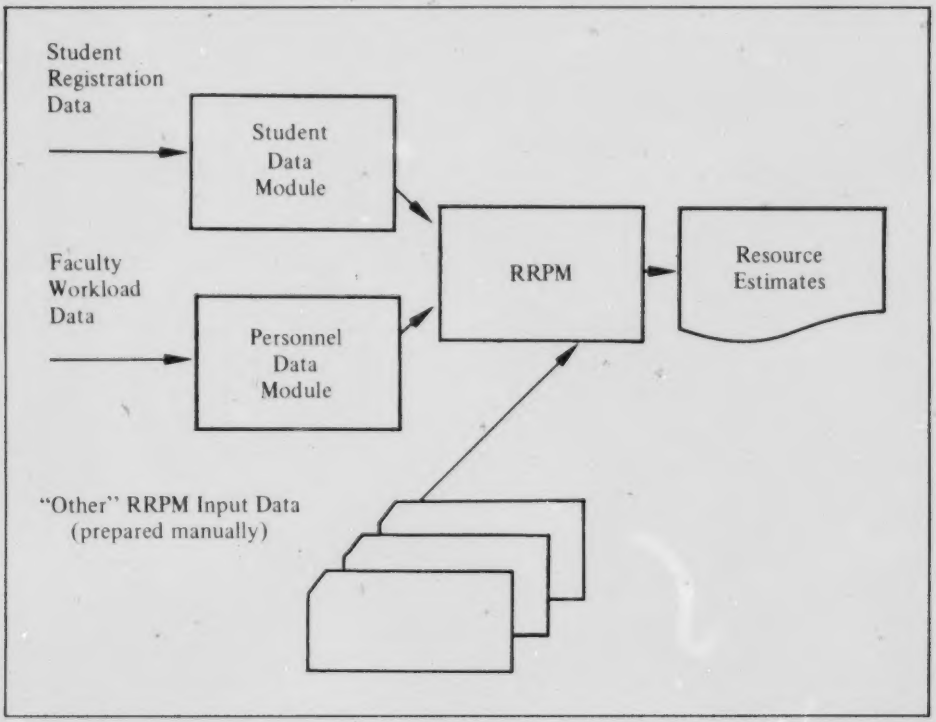
If the main reason for implementing the model is to determine its potential value to the institution—if in effect the model is to be tried out, expenses related to technical implementation should be minimized. This *evaluative* approach to implementation contrasts with the *total-systems* approach, in which a computer-based system is installed to collect and prepare data for input to the model. The total systems approach is appropriate only after the model has been soundly evaluated and judged useful.

Data Preparation

Figure 8 shows the three kinds of data required for RRPM input and the use of two modules of the NCHEMS Costing and Data Management System (CADMS) to process and format these data. With respect to implementation planning, it will be sufficient to summarize what data preparation and formatting entail. In developing an implementation plan, however, technical staff should review the details in following sections of this document as an aid to estimating the time required for each planning task outlined here. (Data preparation and formatting are described in some detail in chapter 4.)

Using data describing the courses taken by each student in each term of a past year, the Student Data Module (SDM) develops an ICLM and other student-related data for input to the model. Both the SDM and the Personnel Data

Figure 8
Data-Collection Systems Flow



Module (PDM) are also generalized software. That is, they require as input a set of data that will build internal tables to define each of the codes used for such data elements as student majors and departments. The following implementation tasks are involved:

1. Collect student registration data in the format required by SDM
2. Code the necessary internal tables required by SDM to define each of the codes used in the registration data
3. Process registration data using SDM software to develop an ICLM
4. Reconcile credit hour, headcount, and FTE student tabulations with

registrar reports to ensure accuracy of the ICLM
5. Revise or reprocess data to eliminate errors
6. Generate RRPM input data

The Personnel Data Module (PDM) performs an analysis of faculty-related data to compute average salaries, average credit hour workloads, and average rank distribution for faculty in each discipline. Tasks involved in planning this work include:

1. Collect faculty-related data for input to PDM
2. Code internal tables used to define coding conventions in the faculty data
3. Process data using PDM to produce workload reports
4. Review PDM reports to reconcile that all the instructional faculty and their complete workloads have been included in the analysis
5. Revise and reprocess data to eliminate errors
6. Generate RRPM input data

The *other* data required by RRPM include the staffing formulas (for example, for secretaries), nonpersonnel expenditure formulas (for such items as supplies and services), and descriptive data (names of divisions, departments, ranks, course levels, and so on). For project planning, the following tasks might be included:

1. Determine the level of detail to be used for each of the *other* data categories included in the model
2. Define the categories in the format required by the model
3. Develop the necessary formulas for input to the model

Developing a Project Plan

A plan to implement the model should include the same set of milestones, regardless of campus size or the strategy employed. However, the time required for the project (and for each milestone) varies with the size or complexity of the institution, size of the project staff, priority of the project, and, most important, with availability of data.

The steps outlined below provide an organizing framework for RRPM implementation. The project coordinator should clearly understand whether the strategy is one for *evaluating* the model or for developing a *total-systems* approach to its installation. Where the campus is interested in evaluating the

model, the project plan should minimize the work on data collection without compromising data accuracy. This can be done by collecting data for a sample of the institution (a college or a department) or by manually calculating some input (again for a sample) rather than developing computer programs, or implementing available software such as the NCHEMS Costing and Data Management System to prepare RRPM input data (see chapter 4). A shortcut might be to develop the necessary software interface with the NCHEMS Student Data Module software to produce an ICLM for input to RRPM. Faculty-related data can be manually collected for a sample of academic departments and processed, using PDM software again to format RRPM input. *Other* data required for input to the model can also be collected for the same academic departments. This approach will shorten the time required to produce an initial (although incomplete) set of RRPM output. It also will train project staff regarding the data requirements, interfaces, and outputs of SDM, PDM, and RRPM.

The steps in an overall RRPM project plan might include:

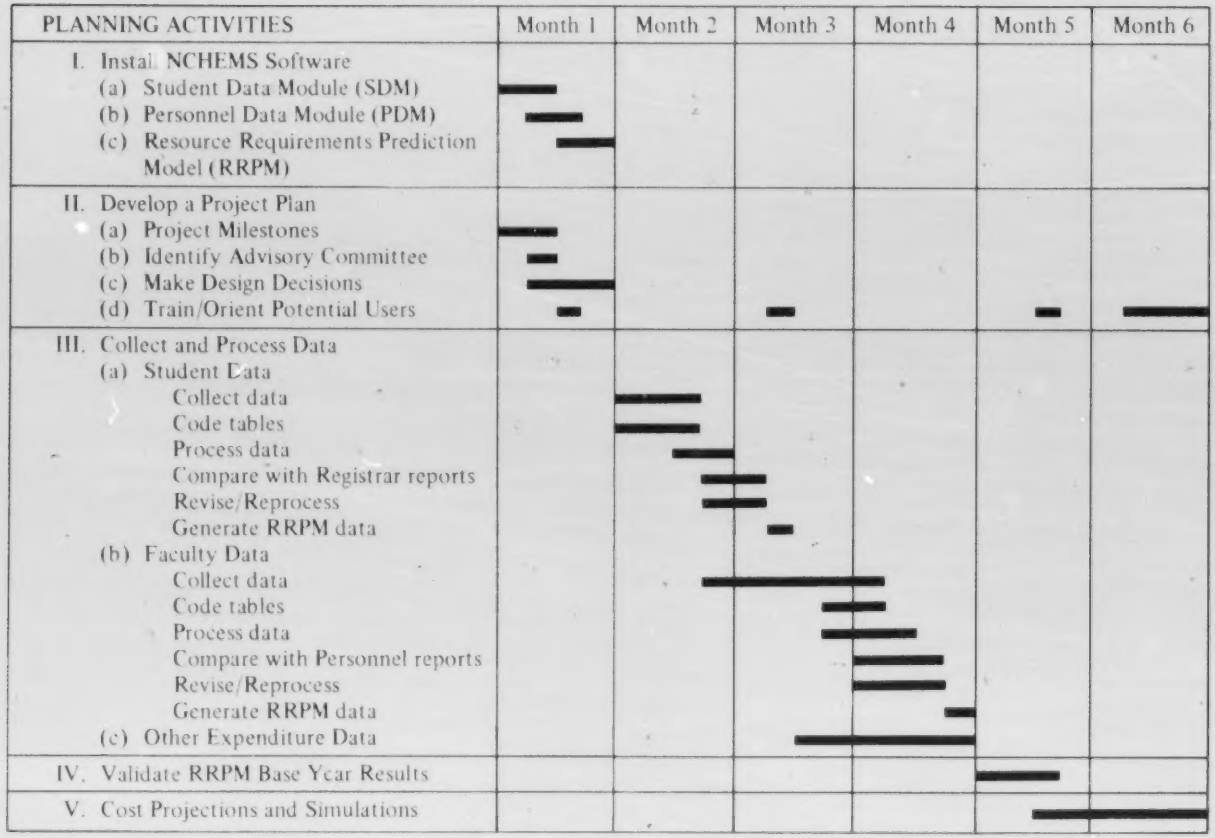
1. Obtain and install the NCHEMS Costing and Data Management System software with test data.
2. Develop an implementation plan that includes—
   (a) project milestones with dates,
   (b) a project advisory committee,
   (c) an agreed set of design decisions for the model, including the levels of detail (or aggregation) to be used, coding structure, and data-collection procedures, and
   (d) training or orientation activities for potential users.
3. Collect and process student, faculty, and *other* expenditure data to prepare RRPM inputs.
4. Validate the model by comparing its results with a base year for which historical data are available.*
5. Use the model for cost projections (simulations).

Within each of these broadly defined steps, there are a number of implementation tasks. In succeeding chapters, these tasks are discussed in detail.

Figure 9 is a hypothetical plan for a six-month implementation project. As we have noted, the time required to implement the model will vary with a number of

*Validation (described in chapter 4) is the process that determines how well the model can approximate past periods for which actual data are available for comparisons.

Figure 9
A Hypothetical RRPM Implementation Plan



considerations. Where there is little or no previous experience with the NCHEMS Costing and Data Management System, an RRPM implementation may require anywhere from four to ten calendar months.

Project staff for an RRPM implementation should include expertise in the following areas:

Computer Personnel—Staff who are familiar with the availability and format of student-registration and faculty-related data (course assignments, academic rank, salaries). They also will set up and operate the NCHEMS software used in the project (SDM, PDM, and RRPM).

Administrative Office—Staff from a number of administrative offices, available on an ad hoc basis, to assist in many of the early decisions on design and detail for the model and used in the later part of the project to help validate the results. These offices might be asked to assist in providing data for input to the model where computer-based records are not available. Such offices would include student records, personnel, payroll, and accounting.

Project Coordination—Coordination of data collection, RRPM processing, and validation should be centered in an office that has a working relationship with the computer center and other administrative offices mentioned above. This is usually a staff unit such as Institutional Research or the Planning Office. The project coordinator must be responsible for coordinating the technical aspects of the project as well as for providing the necessary orientation to potential users and stimulating their involvement in design decisions.

Design Decisions to Guide the Project

To use a generalized planning model such as RRPM, an institution must make four basic decisions early in the implementation process to serve as guides throughout the project. Some of these decisions are technical, such as what types of coding conventions will be used in representing data. Others are more policy related—for example, whether to use a faculty-activity-analysis survey to collect faculty-workload data. What follows is a discussion of the issues involved in each decision.

Decision 1: The level of detail to be included in the model

As a generalized model, RRPM provides flexibility in the definition of instructional disciplines, student majors, course levels, student levels, faculty ranks, and so forth. Each of these might be referred to as *data categories.* As distributed

by NCHEMS, RRPM software makes no presumptions about how many elements, if any, appear in each data category. While there are limits on the number of elements allowed in each category, the user must define the codes used in each category and collect data consistent with these definitions. For example, a category such as *faculty rank* might be defined to include professor, associate professor, assistant professor, instructor, and part-time instructor. When faculty-workload data are prepared for input to the NCHEMS software (PDM), the data for each faculty member must have a code designating one of these ranks. Having the user define codes for the model allows each campus to use its existing codes for all types of data, thereby reducing the work in preparing input data for SDM and PDM.

In defining each data category, one must consider whether the data available from campus records are consistent with the definition, and how much or how little detail is needed by those who will ultimately use the model. Figure 10 illustrates each of these data categories and provides examples, and shows the maximum number of entries allowable in each category. Minor software modifications can be made to expand the number of disciplines, departments, schools, or majors accommodated to a maximum of 9,999. Changes to the limits of the other data categories are more difficult and are not recommended. The category *instruction type* must be defined only when long-method RRPM data are prepared for the model, as described in appendix A.

An advisory committee might consider the level of detail that existing data will support and the detail desirable for resource simulations. In determining the appropriate level, the ultimate purpose of the simulations should be considered. Such committees tend to opt for all the detail possible, on the general principle that more is better. NCHEMS recommends that early results produced by the model use the *least* amount of detail possible. This will simplify both the validation of initial results and training of users, as report content is more condensed. However, data collected for input to SDM and PDM should include all the detail possible. In chapter 4, the concept of *conversion* is developed to explain how detailed input data can be aggregated into less detailed data categories. For example, faculty-rank codes included as input to PDM might be coded as:

PR — Professor
AP — Associate Professor
TP — Assistant Professor
IN — Instructor
PT — Part-time Instructor

Figure 10
RRPM Data Categories

Organizational Levels	Course Levels	Student Levels	Instruction Types	Faculty Ranks	Staff Categories
1. Discipline	1. Freshman	1. Freshman	1. Lecture	1. Professor	1. Admin. Assistants
2. Department	2. Sophomore	2. Sophomore	2. Discussion	2. Associate Professor	2. Secretaries
3. School	3. Junior	3. Junior	3. Laboratory	3. Assistant Professor	3. Student Help
	4. Senior	4. Senior	4. Independent Study	4. Instructor	4. Other
	5. Graduate 1	5. Graduate 1	5. Other	5. Part-time Instructor	
	6. Graduate 2	6. Graduate 2		6. Other	
	7. Other	7. Other			

Other Expense Types	Disciplines	Departments	Schools	Student Majors
1. Equipment	1. Botany	1. Biology	1. Arts & Science	1. English
2. Supplies	2. Zoology	2. Chemistry	2. Engineering	2. History
3. Travel	3. Biochemistry		3. Business	3. Sociology
4. Printing	•	•		•
5. Telephone	•	•	•	•
6. Rentals	•	•	•	•
7. Miscellaneous	200	100	•	200
			50	

* For these categories, the software can be modified to extend the limit for each to 9*. See RRPM System Documentation (Collard and Haight, 1973).

The PDM can be used to convert, or combine, codes into the following categories:

FT — Full-time faculty (includes codes PR, AP, TP, and IN)
PT — Part-time faculty

In this way, rerunning the PDM software will produce another combination of codes, using the original set of PDM input data shown above.

Decision 2: Defining a past period as the basis for cost projections

This period is referred to throughout this document as the *base year.* The *base year* should represent an established planning period, such as an academic year or fiscal year. Data will be developed to describe the operating characteristics (workloads, salary schedules, and so on) of instructional disciplines for the base year. The model will then be validated by comparing its simulation of the base-year operation to the actual expenditure patterns in that year. RRPM approximates resource needs in future planning periods by simulating changes to base-year data.

Decision 3: Determining the method used to document faculty workloads

In preparing the faculty-related input to the model, each faculty member's workloads (in the base year) must be analyzed to develop parameters for departmental salary and workload patterns. Workload data may either be *faculty activities* or *faculty assignments.* These terms are used to describe separate techniques for collecting faculty-related data. Faculty-activity data generally are developed by having faculty complete a self-reporting survey form that documents all the professional activities (and their associated time) of each faculty member. Faculty-assignment data, on the other hand, usually are obtained from existing campus records and describe the assigned duties of faculty members, such as instruction (on a teaching-load basis) and administrative responsibilities and research (on a released-time basis).

Under ideal circumstances, a faculty-activity analysis provides the best documentation of all the duties of faculty members. However, as Leonard Romney (1971) has observed, "one of the most vexing problems concerning the analysis of faculty time devoted to activities has to do with the validity of the data collected. An activity analysis is an extremely complex proposition that requires considerable cooperation and understanding on the part of faculty and academic administrators. Unless there is a clear understanding of the use of the data, and

unless there is a good feedback of results, the value and quality of data are highly suspect. . . ." The best implementation strategy is probably to use whatever data are available for the initial run of the model. Instituting a faculty-activity analysis solely to support RRPM probably is not justifiable at least in the early stages of implementation.

Decision 4: Developing common coding conventions for data used in the model

The coding conventions used to identify discipline and course levels in student-registration data used in the development of an ICLM (utilizing the Student Data Module) must be consistent with faculty-workload data (analyzed with Personnel Data Module), and consistent also with the planning parameters developed for each department in the *other* category of data. The NCHEMS software modules used to process student and faculty data have a conversion feature that allows the modification of codes. The conversion feature allows for the possibility that different coding schemes are used in student-registration data and faculty-assignment files that are both maintained in computer format. In this case, the NCHEMS software can be used to convert different coding schemes for a data category, such as discipline, into a common coding format.

In the chapters to follow, an alphabetic code is used as an example of discipline codes, while student major codes are converted into the HEGIS taxonomy* to demonstrate this conversion feature. The discussion of input data in Chapter 4 uses the following codes by way of example:

Course Levels	Student Levels
LD—Lower Division	20—Lower-Level Students (Freshmen and Sophomores)
UD—Upper Division	30—Upper-Level Students (Juniors and Seniors)
	50—Graduate-Level Students

Faculty Ranks	
PR— Professor	TP— Assistant Professor
AP— Associate Professor	IN— Instructor
	PT— Part-time Instructor

RRPM requires that for each of the data categories listed above, a two-digit alphanumeric code be used on input data formats.

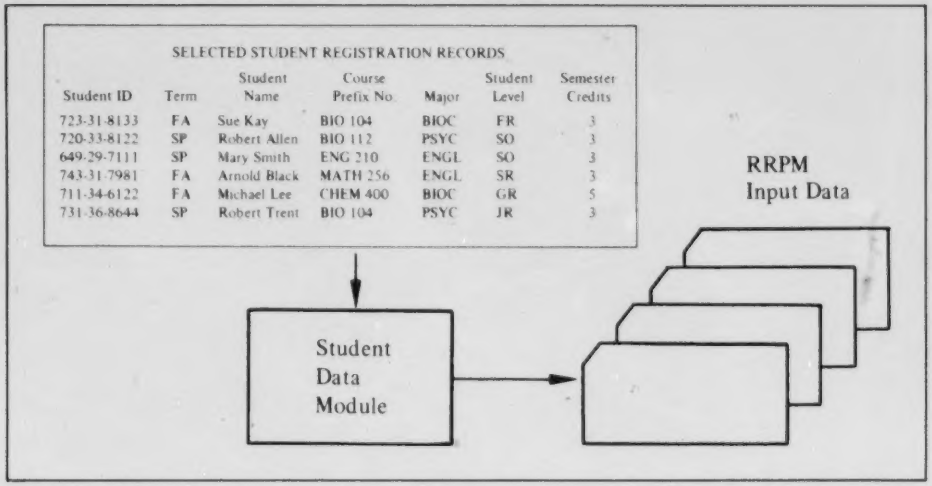
*This taxonomy, used by the National Center for Education Statistics, is further described in the NCHEMS *Program Classification Structure* 2nd ed. (Collier 1976).

Chapter 4
Data Collection

RRPM requires three types of student-related data that include: (1) an Induced Course Load Matrix, (2) enrollment projections by student major, and (3) definitional data. The model requires that an ICLM be developed for a time period (a past academic or fiscal year) to be used as a base year for cost projections. For each student program or major in the ICLM, data on the number of students enrolled must be entered. In a validation run, these enrollment figures are the actual number of students enrolled in the base year. For a projection run, the figures are enrollment projections for the year being simulated. The final set of student-related data is the definition of student majors and disciplines.

The Student Data Module (SDM) is designed to assist in preparing student data for input to RRPM. (The *Student Data Module Reference Manual* [Haight] describes all the technical features of SDM.) By providing student-registration data to the SDM software, as shown in figure 11, an ICLM is computed, FTE or headcount enrollments are tabulated for the base year, and the names of student majors and disciplines are maintained. These data are then formatted for input to RRPM. These are the only student data required for a validation run of the model. For predictive runs, the actual enrollments must be modified or replaced to represent the number of students expected in the year being simulated.

Figure 11
Student Data Module Overview


SELECTED STUDENT REGISTRATION RECORDS
Student ID | Term | Student Name | Course Prefix No. | Major | Student Level | Semester Credits
723-31-8133 | FA | Sue Kay | BIO 104 | BIOC | FR | 3
720-33-8122 | SP | Robert Allen | BIO 112 | PSYC | SO | 3
649-29-7111 | SP | Mary Smith | ENG 210 | ENGL | SO | 3
743-31-7981 | FA | Arnold Black | MATH 256 | ENGL | SR | 3
711-34-6122 | FA | Michael Lee | CHEM 400 | BIOC | GR | 5
731-36-8644 | SP | Robert Trent | BIO 104 | PSYC | JR | 3
RRPM
Input Data
Student
Data
Module

Historical student-registration data must be collected for input to SDM. An example of these registration data and the SDM input-record format are shown in figure 12. Student-registration data generally are maintained in campus computer systems. If so, computer programs should be written to extract the data in the proper format for SDM input. If the data are not available through a computer-based system, either the input records for SDM must be prepared manually, or the ICLM must be developed without the assistance of SDM.

The planning functions that RRPM supports generally focus on the resource requirements needed to begin a term or academic year. It follows, then, that the ICLM data should show the course-taking patterns for students early in each term of the year. The registration data should be obtained from computer files (or developed manually) early in each term, preferably at the census date (the time following registration drop/add when many registrar enrollment reports are prepared). This aids in developing an ICLM using data from early in each term and allows the use of existing registrar reports to validate the SDM enrollment and credit-hour tabulations.

The SDM registration-data records in figure 12 contain the following data elements:

Figure 12
Student Registration Data

SELECTED STUDENT REGISTRATION RECORDS

Student ID	Term	Student Name	Course Prefix No.	Major	Student Level	Semester Credits
723-31-8133	FA	Sue Kay	BIO 104	BIOC	FR	3
720-33-8122	SP	Robert Allen	BIO 112	PSYC	SO	3
649-29-7111	SP	Mary Smith	ENG 210	ENGL	SO	3
743-31-7981	FA	Arnold Black	MATH 256	ENGL	SR	3
711-34-6122	FA	Michael Lee	CHEM 400	BIOC	GR	5
731-36-8644	SP	Robert Trent	BIO 104	PSYC	JR	3

STUDENT DATA MODULE | SDM

STUDENT REGISTRATION DATA RECORD

REQUIRED | INPUT SDM-01

Student Identifier
7 2 3 3 1 8 1 3 3
1 2 3 4 5 6 7 8 9 10

Term (ACTI)
F A
11 12 13 14

Program (COL)
B I O C
15 16 17 18

Student Level (SCOL)
F R
19 20 21 22

Discipline (ROW)
B I O
23 24 25 26

Course Level (SROW)
1 0 4
27 28 29 30

Units
3 0 0
31 32 33 34

Weight Code
P H E D
35 36 37 38

This represents the formatted Student Registration Record for Sue Kay. All Student Records must be prepared in this format for SDM.

Student Identifier—A student ID number used to calculate headcount enrollments in each major. The field is not required unless headcount data are needed on reports for validation.

Term—A code showing the term in which the course is taken. This field is not required, but might be helpful for analysis of ICLM data by term.

Student Program—The major or field of study (code) for the student. In figure 12, Sue Kay is a Biochemistry major, which is coded "BIOC" in the registration data.

Student Level—A code representing the academic level of the student such as freshman, sophomore, junior, or senior. Figure 12 shows student levels of "FR" for freshman and "SO" for sophomore students, and so on.

Discipline—The instructional discipline area offering the course. In figure 12, Course Prefix Number shows the code, such as "BIO," used to identify the discipline of Biology.

Course Level—A code or course number that is used to determine the academic level of the course offering, such as lower division. SDM will accept a single code as course level, or can convert a range of course numbers into a single course level.

Units—The credit hours associated with this course.

Weight Code—Used to weight the units field as described under "Unit Weighting Factor" later in this section.

A necessary part of planning an RRPM implementation is determining the level of detail that is to be used in the majors, organizational units (disciplines), student levels, and course levels. A decision on the types of course levels, for example, is made early in the implementation process. Each data element, however, should be collected at the most discrete or detailed level possible. The SDM software can aggregate or combine discrete codes into new codes that are less detailed. Suppose, for example, that the campus elects to use undergraduate and graduate as the student levels in RRPM. Student-registration data should be collected for SDM input with the most detailed student-level coding possible, such as freshman, sophomore, junior, senior, and graduate. Using the SDM conversion feature (to be discussed later in this section), the software can be instructed to combine or aggregate the codes for freshman, sophomore, junior, and senior into a new code for undergraduate. This allows the institution to change a decision on

the level of detail required and simply reprocess SDM without having to collect and format SDM input again.

In collecting registration data for SDM input, the following suggestions might be helpful in dealing with data exceptions that invariably occur:

1. An undefined student major category should be used for students with no declared major or unknown major codes. A separate category for unknown student levels might also be used, though this represents errors in campus data records, and an effort should be made to correct the data or avoid such errors in the future.
2. Undefined or unknown discipline or course-level codes should be corrected since faculty and financial data are also collected using the same coding scheme. It is important in developing an accurate set of base year data that credit hours, faculty, and cost data be accurately attributed to disciplines and course levels.
3. Cross-listed or multiple-listed courses are those of the type that offer some students enrolled in a class credit for instruction in one discipline and others in the same class credit in a different discipline. There are two alternatives for dealing with this exception. First, the data may be collected showing the students enrolled in the disciplines for which they receive credit. In this case, when collecting faculty-workload data, the teaching assignments for faculty members should show, for cross-listed courses, teaching activities in each discipline for which students receive credit. A second alternative is to force the student-registration data to show all students enrolled in a single discipline and to have faculty teaching assignments reflect teaching in the same discipline.
4. Zero credit hours are frequently assigned to laboratory courses. These would have no effect on producing an ICLM/IWLM and need not be included in the SDM input. Other occurrences of zero-credit-hour courses are discussed in the SDM Control Cards section.

Conversion of Student-Registration Data

SDM aids in converting codes used in campus registration data to the RRPM coding structure through use of its conversion feature. In this way, software used by an institution to extract SDM input data from campus data files need not alter the codes used in these files. Through SDM, the codes can be combined into a

more aggregate code, such as freshman and sophomore converted into lower division (see figure 13). This facility also allows the conversion of codes into a new coding structure. In figure 13, the student-major codes are converted into the HEGIS taxonomy to demonstrate this conversion from one coding structure to another. A range of course numbers can be converted into a single course level as shown when, for the campus, the course numbers are constructed so that this relationship to course levels is consistent across all disciplines. A similar conversion chart should be developed for all fields on the student-registration-data records that are converted.

Since the Student Data Module is generalized, it is necessary to define the RRPM codes that are to be used for each type of data element (discipline, major, course/student levels, and term). The Dimension Definition Record (DEFN) is

Figure 13
Conversion of Student Registration Data

	From		To	
Data Element	Institution Codes	Institution Names	RRPM Codes	RRPM Names
Disciplines (ROW)			BIO ENG MATH CHEM	BIOLOGY ENGLISH MATH CHEMISTRY
Student Programs (COL)	BIOC PSYC ENGL	BIOCHEMISTRY PSYCHOLOGY ENGLISH	0414 2001 1501	BIOCHEMISTRY PSYCHOLOGY ENGLISH
Course Levels (SROW)	000-299 300-499	LOWER DIVISION UPPER DIVISION	LD UD	LOWER DIVISION UPPER DIVISION
Student Levels (SCOL)	FR SO JR SR GR	FRESHMAN SOPHOMORE JUNIOR SENIOR GRADUATE	20 20 30 30 50	LOWER LEVEL LOWER LEVEL UPPER LEVEL UPPER LEVEL GRADUATE LEVEL
Term (ACTI)	FA SP	FALL SPRING	INST INST	ACADEMIC YEAR INSTRUCTION ACADEMIC YEAR INSTRUCTION

used to define these codes, as illustrated in figure 14. The Dimension Type field is used to distinguish which data element is being defined, using the abbreviations (ROW, COL, SROW, SCOL, and ACTI) from figure 13. SDM reports will use the codes and names provided through DEFN Records. Note that the RRPM code used for *course levels* and *student levels* must be two characters and "left justified" in the four-digit Code field on the DEFN Record. This is necessary as the RRPM software requires that student/course level codes be limited to two alphanumeric characters. (In all other cases all four digits may be used.) There is also a definition record for a student major (COL) with a code of "4999" and named "UNDECLARED."

Dimension Conversion Records (CNVT) shown in figure 15 are used to convert the institution codes shown in figure 13 into the RRPM coding structure. In figure 15, the institution code of "BIOC" is converted into the RRPM code of "0414" for a student major or a dimension type of "COL." Note that when the code on institutional data is the same as the RRPM code, there is no need for a Conversion Record. When the keyword "ELSE" is used in the From field of a Conversion Record, it instructs the software to convert all codes not otherwise defined or converted into the code shown in the To field on the Conversion Record. In this way, the unknown or undefined major codes are converted into an RRPM code of "4999."

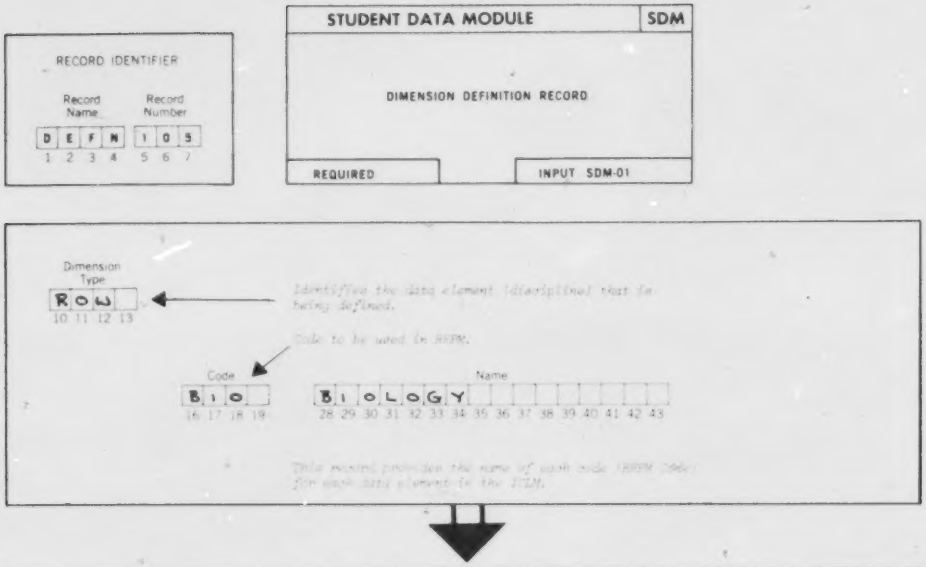
SDM Control Cards

Control cards are used to define processing, reporting, and other input options for the software. The fields on these control cards are described more completely in the *Student Data Module Reference Manual.* Those fields related to processing for purposes of RRPM data preparation are discussed here.

Figure 16 shows the control cards needed by the first of the three SDM programs (SDM-01) with the exception of Definition (DEFN) and Conversion (CNVT) Records. The Zero Units Replacement field on the Control Record is helpful in assigning an arbitrary course credit value to courses that are required, but for which students do not receive any course credit. Frequent examples of such courses are freshman seminars, physical education, and military science courses, or those offered during a special "interim" term. Assigning credit values to these courses might result in an ICLM that more completely describes the historical credit hour demands placed by students on instructional disciplines.

The Unit Weighting Factor Record can be used to weight the credit-hour values

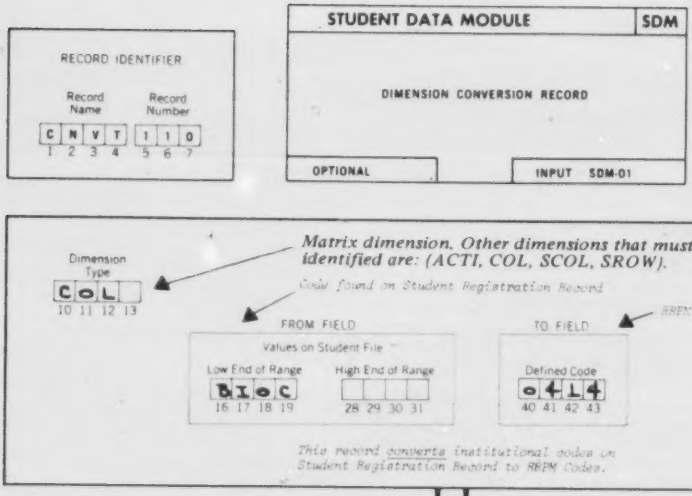
Figure 14
SDM Dimension Definition Records


RECORD IDENTIFIER
Record Name
Record Number
D E F N
1 0 5
1 2 3 4 5 6 7
STUDENT DATA MODULE
SDM
DIMENSION DEFINITION RECORD
REQUIRED
INPUT SDM-01
Dimension Type
R O W
10 11 12 13
Identifies the data element (discipline) that is being defined.
Code to be used in SDM.
Code
B I O
16 17 18 19
Name
B I O L O G Y
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
This record provides the name of each code (BIOL Code) for each data element in the SDM.

DIMENSION DEFINITION RECORDS

DEFN105	ROW	BIO	BIOLOGY
DEFN105	ROW	ENG	ENGLISH
DEFN105	ROW	MATH	MATH
DEFN105	ROW	CHEM	CHEMISTRY
DEFN105	COL	0414	BIOCHEMISTRY
DEFN105	COL	2001	PSYCHOLOGY
DEFN105	COL	1501	ENGLISH
DEFN105	COL	4999	UNDECLARED
DEFN105	SROW	LD	LOWER DIVISION
DEFN105	SROW	UD	UPPER DIVISION
DEFN105	SCOL	20	LOWER LEVEL
DEFN105	SCOL	30	UPPER LEVEL
DEFN105	SCOL	50	GRADUATE LEVEL
DEFN105	ACTI	INST	ACADEMIC YEAR

Figure 15
Dimension Conversion Records



CONVERSION RECORDS

CNVT110	COL	BIOC	0414
CNVT110	COL	PSYC	2001
CNVT110	COL	ENGL	1501
CNVT110	COL	ELSE	4999
CNVT110	SROW	000-299	LD
CNVT110	SROW	300-499	UD
CNVT110	SCOL	FR	20
CNVT110	SCOL	SO	20
CNVT110	SCOL	JR	30
CNVT110	SCOL	SR	30
CNVT110	SCOL	GR	50
CNVT110	ACTI	FA	INST
CNVT110	ACTI	SP	INST

on Student-Registration Data Records. This feature can be helpful in increasing the credit for courses that generally carry small or fractional credit hours, such as music, physical education, and teacher training. The credit hour or Units field value on Student-Registration Data Records having a Weight Code that corresponds to the Weight Code on the Unit Weighting Factor Record is multiplied by the Weighting Factor value. For example, the Weighting Factor of 6.00 in figure 16 would be multiplied by the Units field (3.00) in figure 12 to give the course shown a value of 18 credit hours.

The Zero Units Replacement and Unit Weighting Factor features of the SDM software should be used with caution as they will tend to inflate the total credit

Figure 16
SDM-01 Control Cards

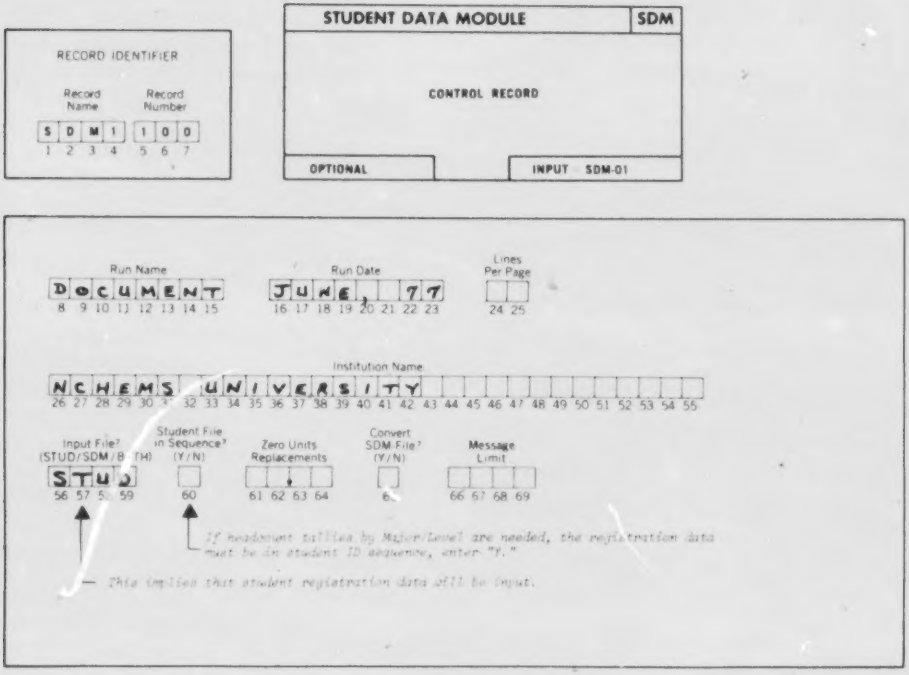
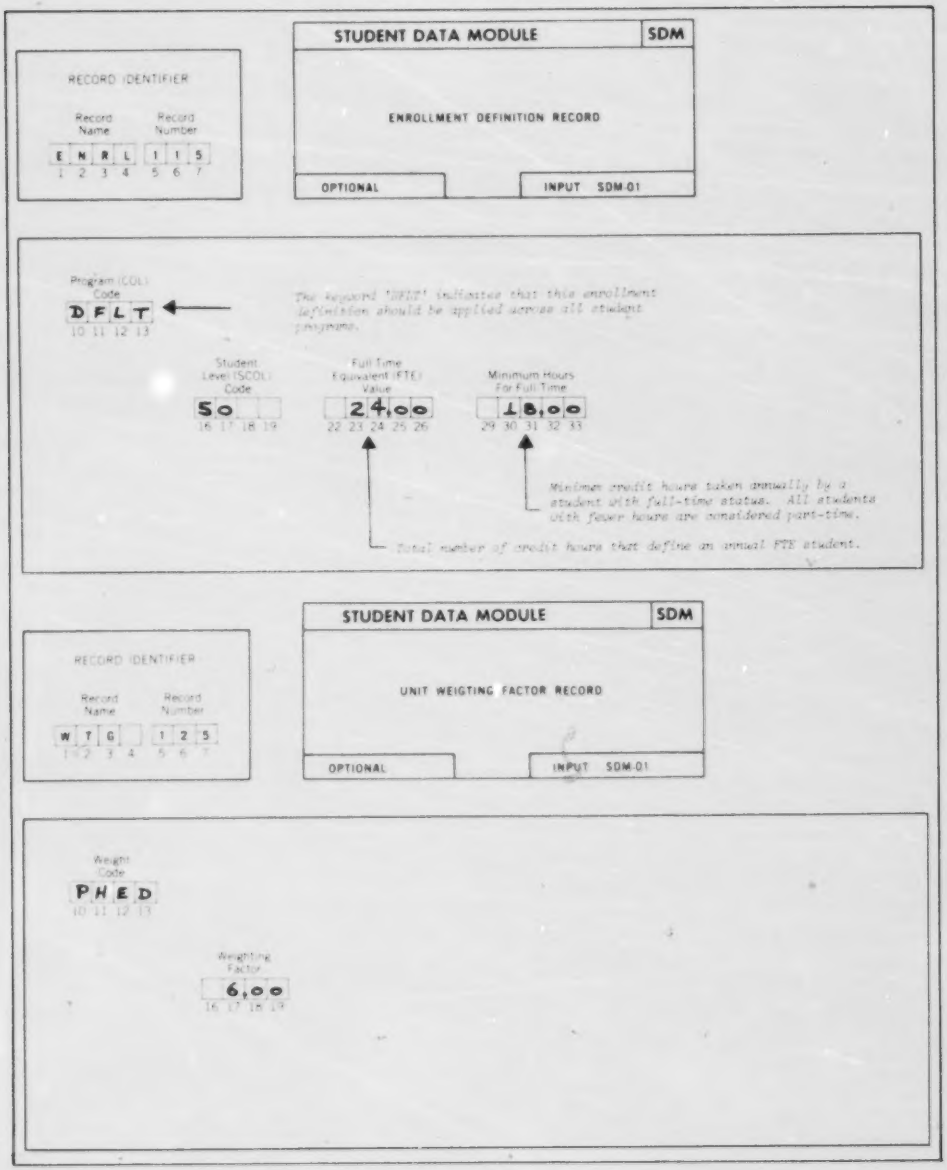

RECORD IDENTIFIER
Record Name
Record Number
S D M 1
1 0 0
1 2 3 4 5 6 7
STUDENT DATA MODULE
SDM
CONTROL RECORD
OPTIONAL
INPUT - SDM-01
Run Name
D O C U M E N T
8 9 10 11 12 13 14 15
Run Date
J U N E , 7 7
16 17 18 19 20 21 22 23
Lines Per Page
24 25
Institution Name
N C H E M S U N I V E R S I T Y
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
Input File? (STUD/SDM/BOTH)
S T U D
56 57 58 59
Student File in Sequence? (Y/N)
60
Zero Units Replacements
61 62 63 64
Convert SDM File? (Y/N)
65
Message Limit
66 67 68 69
If readmount tuition by Major/Level are needed, the registration data must be in student ID sequence, enter "Y."
This implies that student registration data will be input.

Figure 16 (Continued)
SDM-01 Control Cards


STUDENT DATA MODULE
SDM
RECORD IDENTIFIER
Record Name
Record Number
E N R L
1 1 5
ENROLLMENT DEFINITION RECORD
OPTIONAL
INPUT SDM-01
Program (COL) Code
D F L T
10 11 12 13
The keyword 'DFLT' indicates that this enrollment definition should be applied across all student programs.
Student Level (SCOL) Code
S O
16 17 18 19
Full Time Equivalent (FTE) Value
2 4 , 0 0
22 23 24 25 26
Minimum Hours For Full Time
1 8 , 0 0
29 30 31 32 33
Minimum credit hours taken annually by a student with full-time status. All students with fewer hours are considered part-time.
Total number of credit hours that define an annual FTE student.
STUDENT DATA MODULE
SDM
RECORD IDENTIFIER
Record Name
Record Number
W T G
1 2 5
UNIT WEIGTING FACTOR RECORD
OPTIONAL
INPUT SDM-01
Weight Code
P H E D
10 11 12 13
Weighting Factor
6 , 0 0
16 17 18 19

hours included in an IWLM. This might cause some difficulty in validating SDM reports with registrar's enrollment statistics for the same time period.

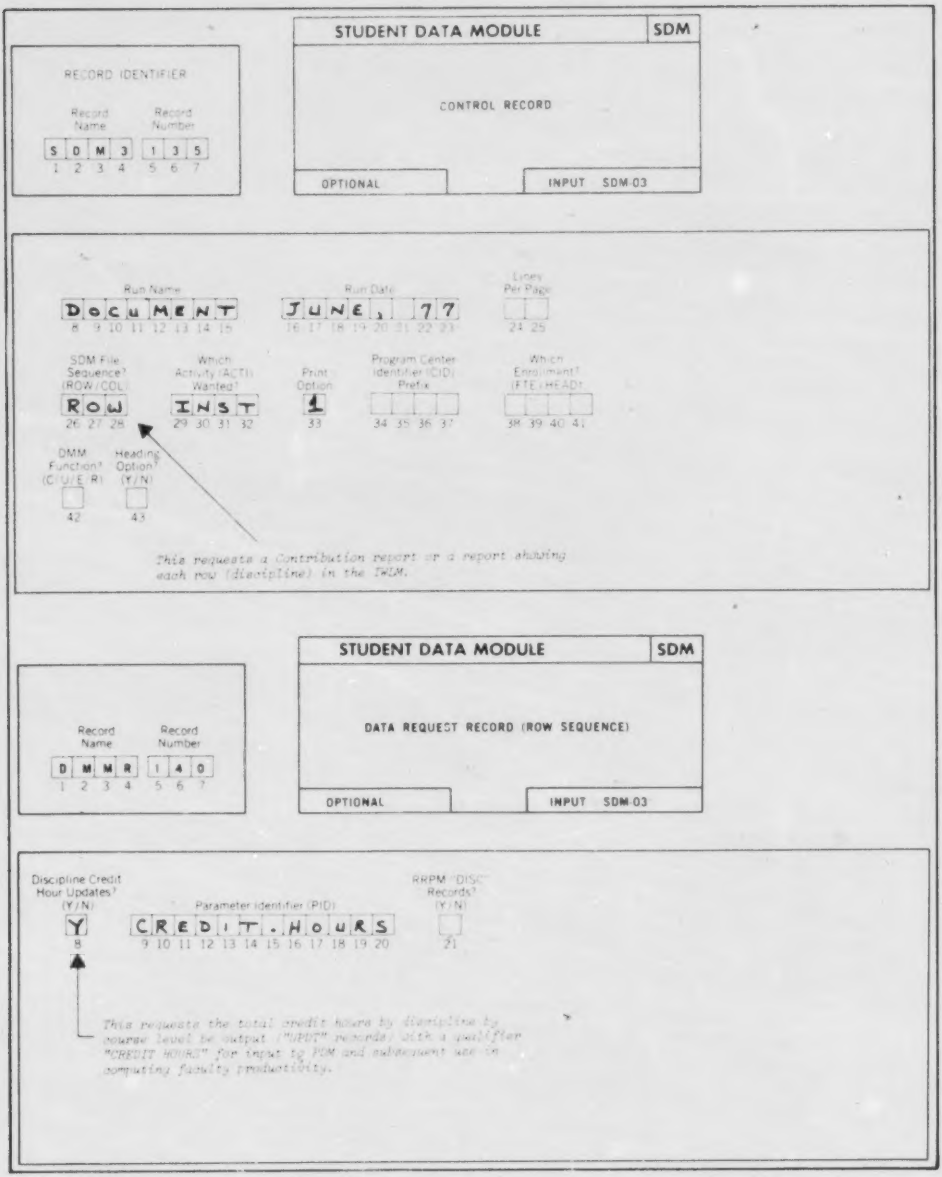
The Enrollment Definition Record in figure 16 is used to define a full-time equivalent (FTE) student in terms of credit hours. The definition can be provided for each major/student-level combination or, using the "DFLT" feature shown, for a single student level across all major codes. The major/student-level codes used must correspond to those used on Dimension Conversion Records. When an Enrollment Definition Record is provided for a single student level, as shown in figure 16, similar records should be included for other student levels. If at least one Enrollment Definition Record is provided, the SDM software requires an Enrollment Definition Record with "DFLT" entered in the Program Code field and Student Level Code field and values for FTE and minimum hours to be used under conditions not defined by other such records. The Minimum Hours for Full-Time field contains a value that specifies the number of hours a student must take during the planning period to be considered a full-time enrolled (versus part-time) student. Subsequent reports will then show headcount students enrolled full time and part time.

The Control Record and Data Request Records shown in figures 17 and 18 are input to the third SDM program (SDM-03). They specify report options and request the data to be formatted and output for RRPM. Figure 15 (SDM3 and DMMR) shows the control-card setup to produce the "Contribution" report, or a listing by discipline showing the credit hours taught to each major. The DMMR Record is used in this run to request the credit-hour totals for each discipline and course level. These output data are then input to PDM and used in the computation of productivity ratios. The second set of control cards (figure 18) is used to request the "Consumption" report, or a listing by major showing the credit hours "consumed" from each discipline. This second run also requests that RRPM data be output in "card-image" format.

SDM Reports

Each of the modules in the Costing and Data Management System produces two types of reports. The first is an edit/error report that documents any errors encountered in the input data to the module. The first SDM program produces such an edit report. Other reports summarize the results of the processing or computations done by the module. Figures 19 and 20 illustrate these reports from SDM. For a more complete description of all reports produced by the system, see

Figure 17
Contribution Report Control Cards



NCHEMS Costing and Data Management System—Sample Reports, Technical Report No. 56.

The two principal reports produced by the Student Data Module are the Contribution (figure 19) and the Consumption (figure 20) Reports. The Contribution Report shows the credit hours generated by each discipline and course level and the student majors/student levels to which the credit hours were contributed. The Consumption Report shows the credit hours "consumed" by each student major/level and the disciplines/course levels from which the credit hours were taken.

Figure 21 shows data formatted for input to RRPM that include: (1) the number

Figure 18
Consumption Report Control Cards

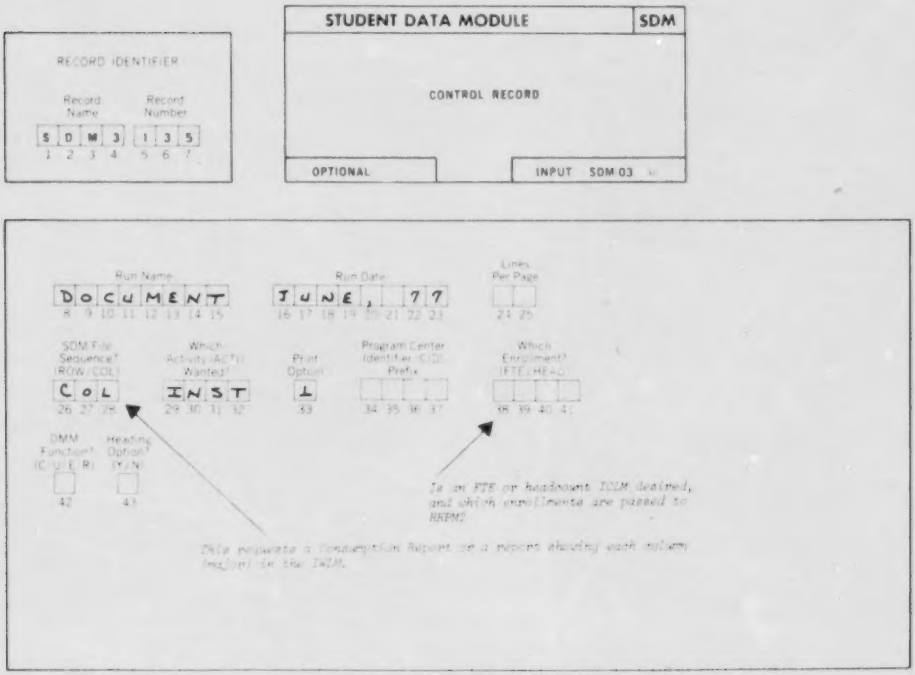
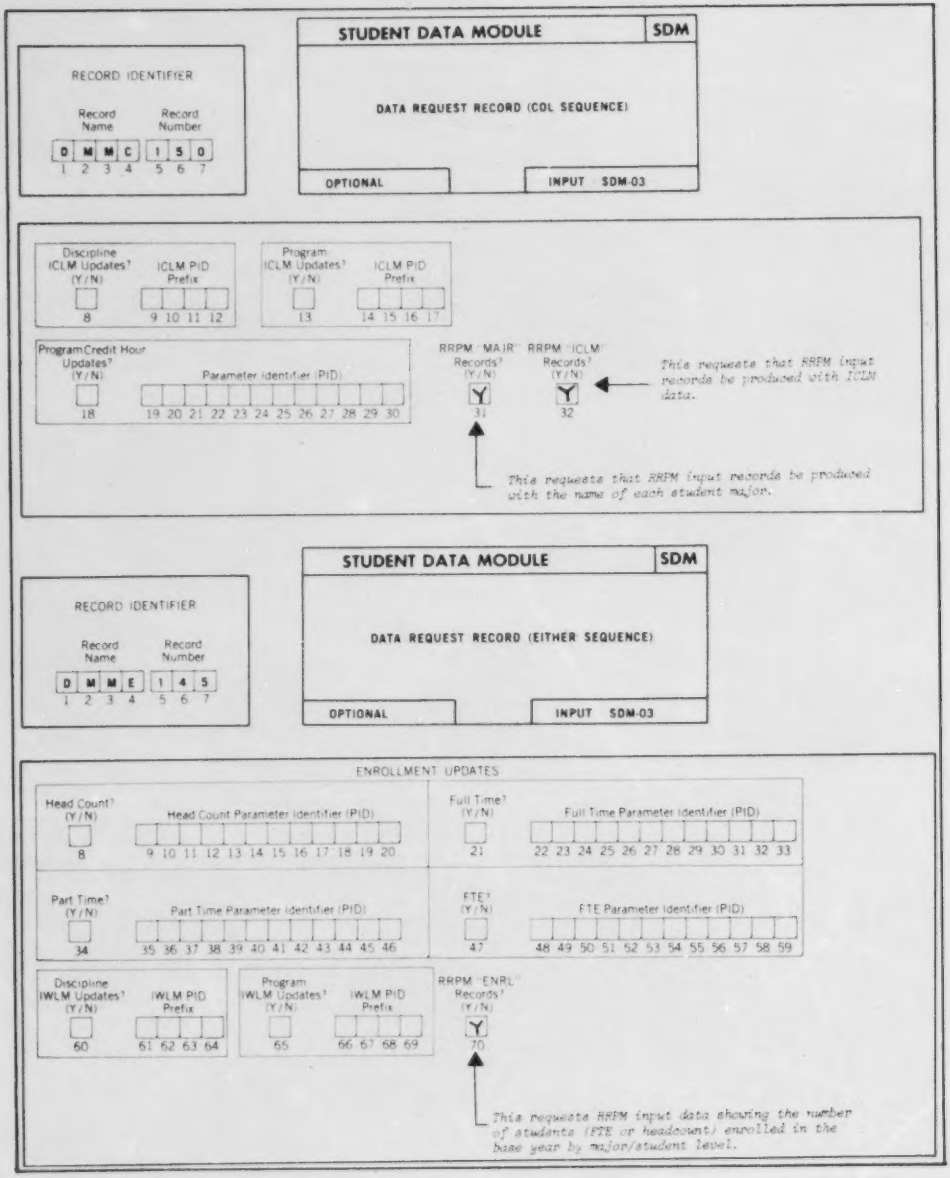

RECORD IDENTIFIER
Record Name
Record Number
S D M 3
1 3 5
STUDENT DATA MODULE
SDM
CONTROL RECORD
OPTIONAL
INPUT SDM-03
Run Name
D O C U M E N T
Run Date
J U N E , 7 7
Lines Per Page
SDM File Sequence? (ROW/COL)
C O L
Which Activity (ACTS) Wanted?
I N S T
Print Option
L
Program Center Identifier (CID) Prefix
Which Enrollment? (FTE/HEAD)
DMM Function? (C U E R)
Heading Option? (Y/N)
Is an FTE or headcount ICOM desired, and which enrollments are passed to RRPM?
This requests a Consumption Report be a report showing each column (major) in the IxDM.

Figure 18 (Continued)
Consumption Report Control Cards


RECORD IDENTIFIER
Record Name
Record Number
D M M C 1 S 0
1 2 3 4 5 6 7
STUDENT DATA MODULE
SDM
DATA REQUEST RECORD (COL SEQUENCE)
OPTIONAL
INPUT SDM-03
Discipline ICLM Updates? (Y/N)
ICLM PID Prefix
8
9 10 11 12
Program ICLM Updates? (Y/N)
ICLM PID Prefix
13
14 15 16 17
Program Credit Hour Updates? (Y/N)
Parameter Identifier (PID)
18
19 20 21 22 23 24 25 26 27 28 29 30
RRPM "MAJR" Records? (Y/N)
RRPM "ICLM" Records? (Y/N)
Y
Y
31
32
This requests that RRPM input records be produced with ICLM data.
This requests that RRPM input records be produced with the name of each student major.
RECORD IDENTIFIER
Record Name
Record Number
D M M E 1 4 5
1 2 3 4 5 6 7
STUDENT DATA MODULE
SDM
DATA REQUEST RECORD (EITHER SEQUENCE)
OPTIONAL
INPUT SDM-03
ENROLLMENT UPDATES
Head Count? (Y/N)
Head Count Parameter Identifier (PID)
8
9 10 11 12 13 14 15 16 17 18 19 20
Full Time? (Y/N)
Full Time Parameter Identifier (PID)
21
22 23 24 25 26 27 28 29 30 31 32 33
Part Time? (Y/N)
Part Time Parameter Identifier (PID)
34
35 36 37 38 39 40 41 42 43 44 45 46
FTE? (Y/N)
FTE Parameter Identifier (PID)
47
48 49 50 51 52 53 54 55 56 57 58 59
Discipline IWLM Updates? (Y/N)
IWLM PID Prefix
60
61 62 63 64
Program IWLM Updates? (Y/N)
IWLM PID Prefix
65
66 67 68 69
RRPM "ENRL" Records? (Y/N)
Y
70
This requests RRPM input data showing the number of students (FTE or headcount) enrolled in the base year by major/student level.

of students enrolled in each major/level for the base year, (2) the average credit hour ICLM data, and (3) the names of each student major.

Figure 22 illustrates the "card-image" used to format the total credit hours taught in each discipline/course level. These data are input to the Personnel Data Module (PDM) via the "Control File."

RRPM Faculty Input Data

If the "short-method" of calculating full-time equivalent (FTE) faculty is to be used, the model requires historical faculty data that describe the credit hour workload patterns, salary schedules, and distribution of faculty among academic ranks. These historical data must represent the time period (academic or fiscal year) that is to be used as the base year for cost projections and should be for the same time period for which the ICLM was developed.

The Personnel Data Module (PDM) aids in the preparation of these faculty-related parameters. The software uses input data on individual faculty members and their workloads to develop the average workload, salary, and rank distribution data required by RRPM as shown in figure 23. The PDM (and SDM) output data are in "card-image" format and may be stored on a variety of systems devices such as magnetic tape, disk storage, or cards. For a validation run of the model, these are all the faculty data that are required if the short-method calculations are used. The values of these data may be changed in individual disciplines and levels or by blanket percentage changes when the model is being used for cost simulations (see the section on simulation).

The *Personnel Data Module Reference Manual** documents the complete functions and capabilities of the PDM software. This guide will outline only one use of the PDM, that of performing the computations necessary to prepare faculty input data for RRPM.

The Personnel Data Module distributes faculty annual FTE time and salaries across their activities. For the instructional portion of the faculty members' workloads, RRPM historical parameters (average workload, average salary, and so forth) are computed. The FTE time and salary distributed to noninstructional activities are not included in data prepared for RRPM. One of the objects of reconciliation will be to account for the FTE time and salary for noninstructional activities in each department or budgetary unit.

Figure 24 shows how contact hours are used as the basis for prorating each

*See Haight and Martin (1975).

Figure 19
SDM Contribution Report

SDM-03 N C H E M S U PAGE 2
DOCUMENT SEQUENCE = DISCIPLINE CONTRIBUTION REPORT ACTIVITY=INST INSTRUCTION JUNE, 77
NO ENROLLMENTS THIS SEQUENCE

		PERCENT TOTAL DISC	UNITS MAJR	STUDENT UNITS
BIO	BIOLOGY			
LD	LOWER DIVISION			
0414	BIOCHEMISTRY			
20	LOWER DIVISION	19.20	13.60	655.00
30	UPPER DIVISION	11.60	8.20	395.00
0414	BIOCHEMISTRY	30.80	21.80	1,050.00
1501	ENGLISH			
20	LOWER DIVISION	4.60	4.00	156.00
30	UPPER DIVISION	4.30	3.70	145.00
1501	ENGLISH	8.80	7.80	301.00
2001	PSYCHOLOGY			
30	UPPER DIVISION	5.50	7.80	188.00
4999	ALL OTHER			
20	LOWER DIVISION	12.00	9.10	407.00
30	UPPER DIVISION	3.50	2.60	119.00
4999	ALL OTHER	15.50	11.70	526.00
LD	LOWER DIVISION	60.70		2,065.00
UD	UPPER DIVISION			
0414	BIOCHEMISTRY			
20	LOWER DIVISION	1.30	.90	43.00
30	UPPER DIVISION	14.40	10.20	489.00
0414	BIOCHEMISTRY	15.60	11.00	532.00
1501	ENGLISH			
20	LOWER DIVISION	.10	.10	5.00
30	UPPER DIVISION	2.60	2.30	89.00
1501	ENGLISH	2.80	2.40	94.00
2001	PSYCHOLOGY			
20	LOWER DIVISION	.90	1.20	30.00
30	UPPER DIVISION	10.30	14.60	350.00
2001	PSYCHOLOGY	11.20	15.80	380.00
4999	ALL OTHER			
20	LOWER DIVISION	.80	.60	26.00
30	UPPER DIVISION	9.00	6.80	307.00
4999	ALL OTHER	9.80	7.40	333.00
UD	UPPER DIVISION	39.30		1,339.00
BIO	BIOLOGY	100.00		3,404.00

188 Biology Discipline Lower Division course level credit hours were provided to students majoring in Psychology with a student level of upper division.

These 188 credit hours are 7.8 percent of all credit hours taken by Psychology Upper Division majors.

The 188 credit hours are 5.50 percent of all credit hours produced in the Biology discipline.

Total Biology credit hour production:
Lower Division = 2,065
Upper Division = 1,339

Figure 20
SDM Consumption Report

SDM-03 — N C H E M S U — PAGE 2
DOCUMENT SEQUENCE = STUDENT MAJOR — CONSUMPTION REPORT — ACTIVITY=INST INSTRUCTION — JUNE, 77

	PERCENT TOTAL UNITS MAJR	DISC	STUDENT UNITS	UNITS PER F.T.E.	..... ENROLLMENTS ..... F.T.E.	HEADCOUNT	FULL-TIME	PART-TIME
0414 BIOCHEMISTRY								
20 LOWER DIVISION								
BIO BIOLOGY								
LD LOWER DIVISION	13.60	19.20	655.00	7.99				
UD UPPER DIVISION	.90	1.30	43.00	.52				
	14.50	20.50	698.00	8.51				
BIO BIOLOGY								
CHEM CHEMISTRY								
LD LOWER DIVISION	7.30	17.30	350.00	4.27				
UD UPPER DIVISION	.60	1.30	27.00	.33				
	7.80	18.70	377.00	4.60				
CHEM CHEMISTRY								
ENG ENGLISH								
LD LOWER DIVISION	8.00	14.70	385.00	4.70				
UD UPPER DIVISION	.90	1.60	43.00	.52				
	8.90	16.40	428.00	5.22				
ENG ENGLISH								
MATH MATHEMATICS								
LD LOWER DIVISION	6.60	13.70	319.00	3.89				
UD UPPER DIVISION	.30	.60	15.00	.18				
	6.90	14.40	334.00	4.07				
MATH MATHEMATICS								
OTHR OTHR DISCIPLINES								
LD LOWER DIVISION	9.40	8.70	453.00	5.52				
UD UPPER DIVISION	3.50	3.30	170.00	2.07				
	13.00	11.90	623.00	7.60				
OTHR OTHR DISCIPLINES			2,460.00	30.00	82.00			
	51.10							
20 LOWER DIVISION								
30 UPPER DIVISION								
BIO BIOLOGY								
LD LOWER DIVISION	8.20	11.60	395.00	5.04				
UD UPPER DIVISION	10.20	14.40	489.00	6.24				
	18.40	26.00	884.00	11.29				
BIO BIOLOGY								
CHEM CHEMISTRY								
LD LOWER DIVISION	.90	2.10	43.00	.55				
UD UPPER DIVISION	9.40	22.30	450.00	5.74				
	10.20	24.40	493.00	6.29				
CHEM CHEMISTRY								
ENG ENGLISH								
LD LOWER DIVISION	1.70	3.10	80.00	1.02				
UD UPPER DIVISION	.20	.40	10.00	.13				
	1.90	3.40	90.00	1.15				
ENG ENGLISH								
MATH MATHEMATICS								
LD LOWER DIVISION	1.20	2.50	59.00	.75				
UD UPPER DIVISION	3.00	6.30	146.00	1.86				
	4.30	8.80	205.00	2.62				
MATH MATHEMATICS								
OTHR OTHR DISCIPLINES								
LD LOWER DIVISION	1.70	1.60	81.00	1.03				
UD UPPER DIVISION	12.40	11.40	597.00	7.62				
	14.10	13.00	678.00	8.66				
OTHR OTHR DISCIPLINES	48.90		2,350.00	30.00	78.33			
30 UPPER DIVISION	100.00		4,810.00	30.00	160.33			
0414 BIOCHEMISTRY								
1501 ENGLISH								
20 LOWER DIVISION								

Students majoring in Lower Division Biochemistry took 385 credit hours in Lower Division English courses.

These 385 credit hours are 14.70 percent of all credit hours offered in English.

The 385 credit hours are 8.00 percent of all credit hours taken by students majoring in Biochemistry.

The number of FTE students enrolled in Upper Division Biochemistry

(1) *The average Lower Division Biochemistry student takes 4.70 credit hours from the Lower Division English discipline.*

Figure 21
RRPM Input Data

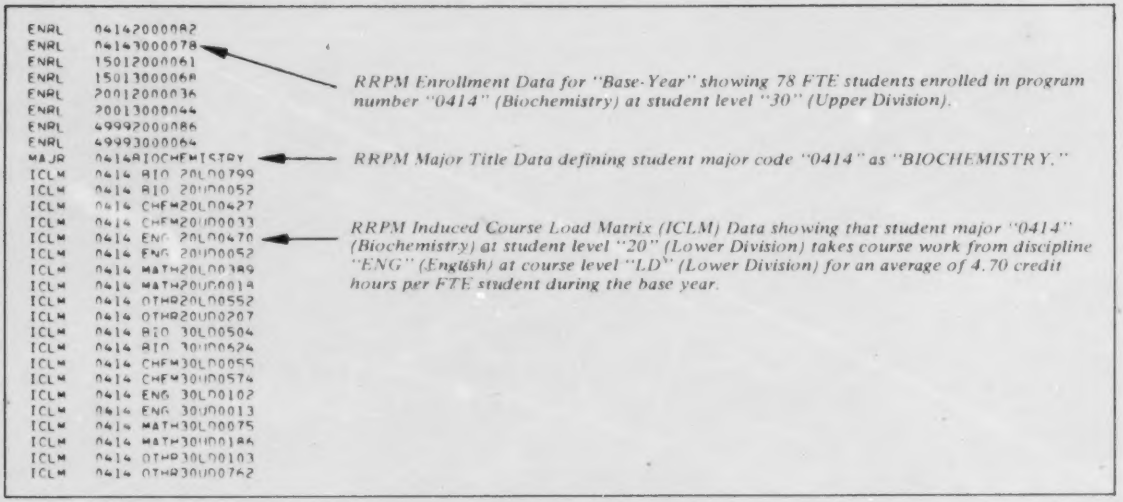

ENRL 04142000082
ENRL 04143000078
ENRL 15012000061
ENRL 15013000068
ENRL 20012000036
ENRL 20013000044
ENRL 49992000086
ENRL 49993000064
MAJR 0414BIOCHEMISTRY
ICLM 0414 BIO 20LD0799
ICLM 0414 BIO 20UD0052
ICLM 0414 CHEM20LD0427
ICLM 0414 CHEM20UD0033
ICLM 0414 ENG 20LD0470
ICLM 0414 ENG 20UD0052
ICLM 0414 MATH20LD0389
ICLM 0414 MATH20UD0018
ICLM 0414 OTHR20LD0552
ICLM 0414 OTHR20UD0207
ICLM 0414 BIO 30LD0504
ICLM 0414 BIO 30UD0424
ICLM 0414 CHEM30LD0055
ICLM 0414 CHEM30UD0574
ICLM 0414 ENG 30LD0102
ICLM 0414 ENG 30UD0013
ICLM 0414 MATH30LD0075
ICLM 0414 MATH30UD0186
ICLM 0414 OTHR30LD0103
ICLM 0414 OTHR30UD0762
RRPM Enrollment Data for "Base-Year" showing 78 FTE students enrolled in program number "0414" (Biochemistry) at student level "30" (Upper Division).
RRPM Major Title Data defining student major code "0414" as "BIOCHEMISTRY."
RRPM Induced Course Load Matrix (ICLM) Data showing that student major "0414" (Biochemistry) at student level "20" (Lower Division) takes course work from discipline "ENG" (English) at course level "LD" (Lower Division) for an average of 4.70 credit hours per FTE student during the base year.

Figure 22
PDM Input Data

```
UPDT9SDINSTBIO LD   CREDIT.HOURSN000000002065000 F
UPDT9SDINSTBIO UD   CREDIT.HOURSN000000001339000 F
UPDT9SDINSTCHEMLD   CREDIT.HOURSN000000001222000 F
UPDT9SDINSTCHEMUD   CREDIT.HOURSN000000000798000 F
UPDT9SDINSTENG LD   CREDIT.HOURSN000000001698000 F
UPDT9SDINSTENG UD   CREDIT.HOURSN000000000919000 F
UPDT9SDINSTMATHLD   CREDIT.HOURSN000000001584000 F
UPDT9SDINSTMATHUD   CREDIT.HOURSN000000000738000 F
UPDT9SDINSTOTHRLD   CREDIT.HOURSN000000002514000 F
UPDT9SDINSTOTHRUD   CREDIT.HOURSN000000002701000 F
```

Indicates the total instructional output in the "BIO" (Biology) discipline at course level "LD" (Lower Division) is 2,065 credit hours.

Funding Account Record

Every faculty member should have a Funding Account Record for each budgetary account from which he is paid. These records document the amount of service provided by the faculty member (FTE and salary) during the previous planning period (academic or fiscal year). Data elements included on this record are:

Person Identifier—This must be the same code as that used on the Person Identifier Record to link the two records together.

Person Qualifier—This field is used only if there is more than one funding account for a faculty member and there is the need to restrict the use of a

Figure 26
Sample PDM Input Data

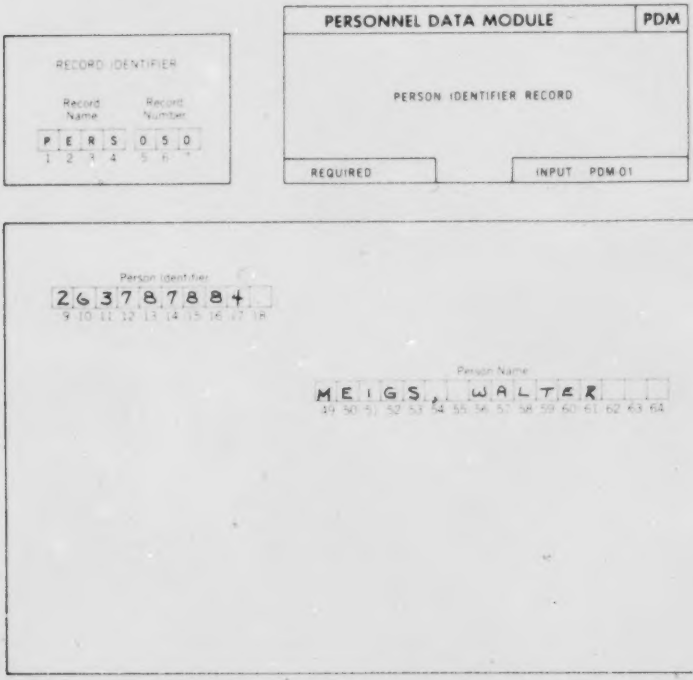
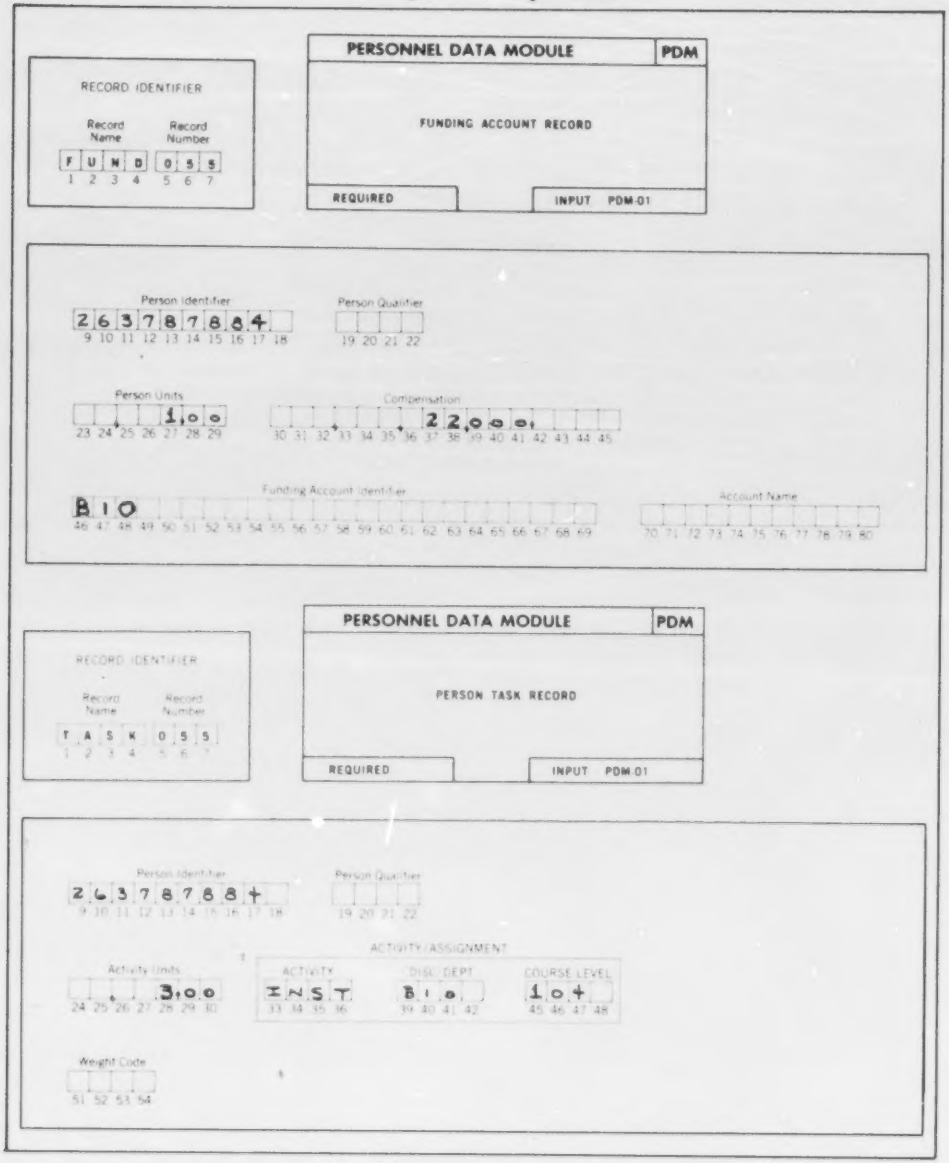

RECORD IDENTIFIER
Record Name
Record Number
P E R S 0 5 0
1 2 3 4 5 6
PERSONNEL DATA MODULE
PDM
PERSON IDENTIFIER RECORD
REQUIRED
INPUT PDM-01
Person Identifier
2 6 3 7 8 7 8 8 4
9 10 11 12 13 14 15 16 17 18
Person Name
M E I G S , W A L T E R
49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
Person Type
P R O F
65 66 67 68

Figure 26 (Continued)
Sample PDM Input Data



particular budgetary account to a specific set of activities. A further explanation of this field is given in the Restricted Funds description of this chapter.

Person Units—The FTE time for the planning period that is funded by the account described on this record.

Person Compensation—The salary paid by this financial account to the faculty member during the planning period. This is the amount *actually* paid rather than an annual rate.

Funding Account Identifier—This field must contain any nonblank character. As an aid in reconciliation, the field might be a code for the department that manages the budgetary account described on this record.

Account Name—This field is optional and has no effect on the computations for PDM outputs.

Figure 26 shows the budgetary data for Walter Meigs (from figure 24) coded on a Funding Account Record.

Person Task Record

Each activity or assignment for the faculty member is identified on a Person Task Record. The data elements for this record include:

Person Identifier—This must be the same code as that used on the Person Identifier Record to link this record to others for the faculty member.

Person Qualifier—This field is used only if there is more than one funding account for a faculty member. The code is used to link the activity described on this record to the particular fund that is supporting it. See the Restricted Funds description later in this chapter.

Activity Units—The number of units, such as hours per week or contact hours, associated with this activity. The unit of measure for all activities related to an individual faculty member must be consistent. That is, when instructional activities are measured in contact hours, noninstructional activities, such as department chairmanship, must also be reported in equivalent contact-hour units.

Activity—A mnemonic that describes the "type" of activity for this faculty member. Examples of this code are "INST" for an instructional activity, or "DCHR" for Department Chairperson.

DISC/DEPT—An identifier for the department or discipline in which the activity took place.

Course Level—This field should be used *only for instructional activities.* It should contain a course-level code or a course number, from which ranges of course numbers can be converted to a unique course level.

Weight Code—Used to weight the Activity Units field (Unit Weighting Factor) as described on page 72.

Figure 26 illustrates the coding of a Person Task Record for one of the courses taught by Walter Meigs.

PDM Record Summary

Each individual analyzed by PDM must have one (and only one) Person Identifier Record, at least one Funding Account Record, and at least one Person Task Record.

Conversion of Personnel Data

PDM will convert codes used in the personnel data into the RRPM coding structure as does the Student Data Module (SDM). It is important that the coding scheme into which SDM data are converted be used also for personnel data. This will ensure that the credit hours tabulated in SDM are attributed to the same discipline code as that used in PDM when accumulating FTE faculty by discipline.

The Person Type, Activity, Discipline/Department, and Course Level fields of the PDM input data must have Definition and Conversion Records prepared. Figure 27 illustrates this conversion and definition of data.

The Personnel Data Module is a generalized software package and must have a definition for the RRPM codes used for each data element (activity, discipline, course level, and faculty rank). Like SDM, these definitions are provided on a Dimension Definition Record (DEFN), as shown in figure 28. In that figure, the code "PR" is defined to mean "PROFESSOR" for the data element abbreviated "TYPE" or faculty rank. The PDM reports will show the codes and names provided through DEFN records. Note that the RRPM code used for *course levels* and *faculty ranks* must be two-characters and "left-justified" in the four-digit Code field on the DEFN record. Activity and discipline codes may use all four digits.

As in SDM, the Dimension Conversion Records (CNVT) shown in figure 29 are used to convert the institution codes shown in figure 27 to RRPM codes. Note that the Conversion Records are not necessary when the institutional codes are the

Figure 27
Conversion of Personnel Data

	From		To	
Data Element	Institution Codes	Institution Names	RRPM Codes	RRPM Names
Activity (ACTI)	INST	Instruction	INST	Instruction
	DCHR	Dept. Chairman	DCHR	Dept. Chairperson
Discipline (ROW)	BIO	Biology	BIO	Biology
	ZOO	Zoology	ZOO	Zoology
Course Levels (SROW)	000-299	Lower Division	LD	Lower Division
	300-499	Upper Division	UD	Upper Division
Person Type or Faculty Rank (TYPE)	PROF	Professor	PR	Professor
	APRF	Associate Professor	AP	Associate Professor
	ASTP	Assistant Professor	TP	Assistant Professor

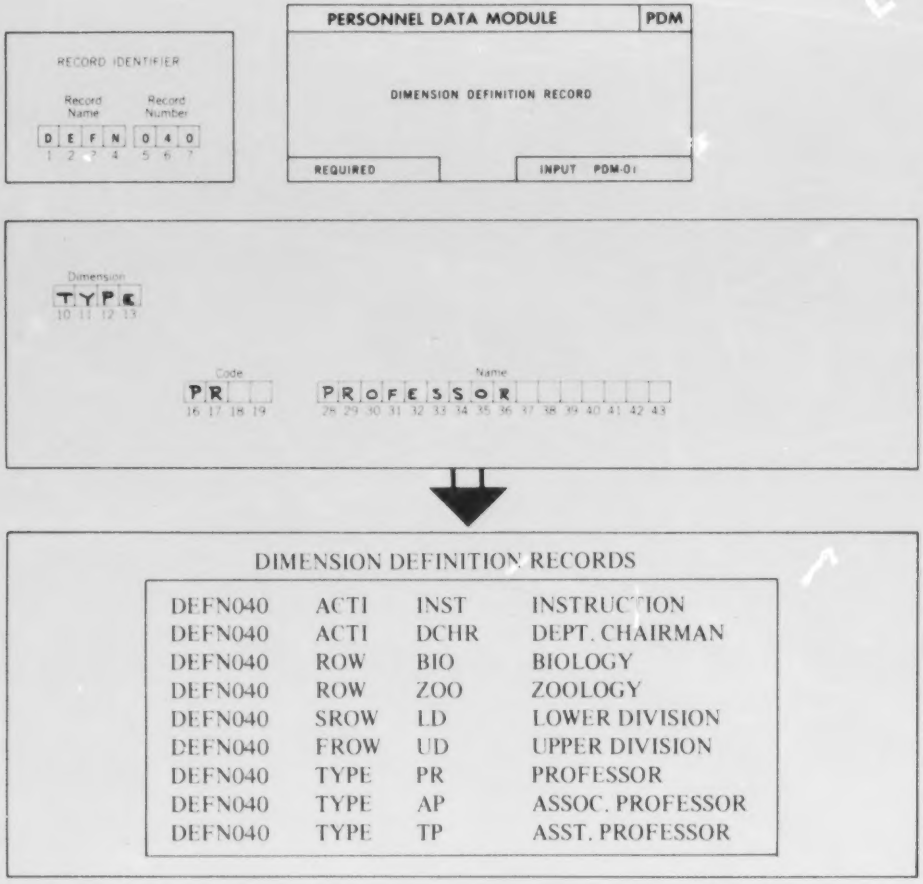
same as the RRPM codes. In such a case, it is only necessary to define the code using a Dimension Definition Record (DEFN).

Restricted Funds

It is frequently the case that a faculty member is paid from more than one fund account when involved in project research as well as instructional assignments. In such a case, a portion of the faculty member's salary is paid by the research grant and the remainder by an instructional account in the campus accounting system.

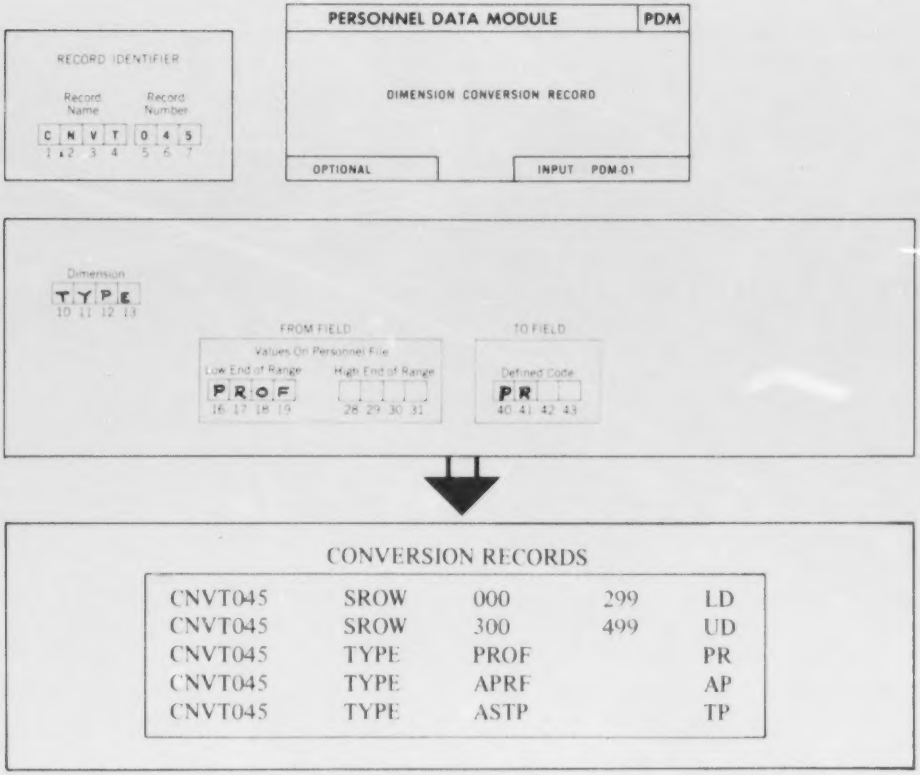
To prepare input data for PDM, it is important to keep in mind that data for RRPM apply only to instructional assignments of faculty. The Personnel Data Module performs an analysis of faculty assignments to separate instructional cost and workloads from noninstructional. The software must deal with two cases in this analysis. One is the faculty member who is paid from a single account in the accounting system for both instructional work and other activities, such as

Figure 28
PDM Dimension Definition Records


RECORD IDENTIFIER
Record Name
Record Number
D E F N 0 4 0
1 2 3 4 5 6 7
PERSONNEL DATA MODULE
PDM
DIMENSION DEFINITION RECORD
REQUIRED
INPUT PDM-01
Dimension
T Y P E
10 11 12 13
Code
P R
16 17 18 19
Name
P R O F E S S O R
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
DIMENSION DEFINITION RECORDS
DEFN040 ACTI INST INSTRUCTION
DEFN040 ACTI DCHR DEPT. CHAIRMAN
DEFN040 ROW BIO BIOLOGY
DEFN040 ROW ZOO ZOOLOGY
DEFN040 SROW LD LOWER DIVISION
DEFN040 FROW UD UPPER DIVISION
DEFN040 TYPE PR PROFESSOR
DEFN040 TYPE AP ASSOC. PROFESSOR
DEFN040 TYPE TP ASST. PROFESSOR

department chairmanship. In this case, the software prorates his full-time equivalency and salary to his respective activity areas. The second case is that of the faculty member paid by both an instructional account and another, such as a research grant. Here it is sometimes necessary to associate the salary from a research grant only with those activities related to research. In doing so, the grant

Figure 29
PDM Dimension Conversion Records



funds (and PDM Funding Account Record) are said to be "restricted" to those activities that are research related.

For a faculty member paid from funding accounts and for whom the restricted notion is used, either of two alternatives may be used:

Alternative 1: Use the Person Qualifier field of the PDM Funding Account Record and Person Task Record. For each faculty member, a character string in the Person Qualifier field is used to link a specific fund to the tasks it supports. For

example, a Funding Account Record for a research grant could have a Person Qualifier of "R" to designate the account as research. The same character value of "R" must then appear as the Person Qualifier field on the Person Task Records for the faculty member's research activities. The instructional funding account and related activities for the same faculty member might use a character such as "I" to link the fund and task records. Note that blanks are an acceptable character string.

Alternative 2: Since RRPM is an instructional costing model, the PDM analysis separates instructional activities with their associated cost from noninstructional activities. Parameters for RRPM are developed from the instructional set of activities only. An alternative, then, is not to include any noninstructional activities that are *funded by separate accounts or research grants.* What is included under this alternative is the instructional account and any activities for a faculty member that are considered funded by that account. Both the research funds and activities would be excluded from PDM input data and therefore not included in the analysis.

PDM Control Cards

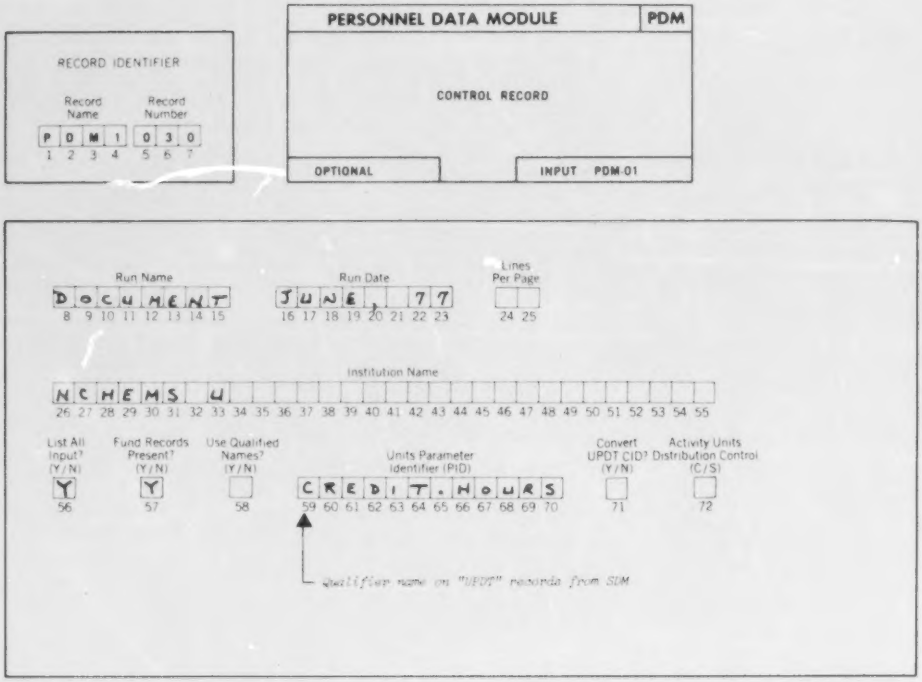
Control cards are used in PDM to control the processing, reporting, and output specifications. Each field on the PDM control cards is fully described in the *Personnel Data Module Reference Manual.* Those fields necessary for RRPM data preparation are discussed here.

The PDM programs necessary for processing RRPM data are only PDM-01 and PDM-03. The control cards are provided for processing the first four PDM programs for illustration purposes and in order that the reports from each program can be explained.

Figure 30 shows the control card needed by the first PDM program. It is combined with the Definition and Conversion Records and the "UPDT" Records produced by SDM. These records are entered via the Control File to PDM-01, while the Person, Fund, and Task Records are entered as the Activity File (see the *PDM Reference Manual,* p. 6). A Unit Weighting Factor Record may be included (not shown here) with the control cards. It performs a function similar to the "WTG" record in SDM except that the weighting factor is applied to the activity units (contact hours) field of the Task Record.

Figure 31 shows the control cards for the remaining PDM programs to produce

Figure 30
PDM-01 Control Record


RECORD IDENTIFIER
Record Name
Record Number
P O M 1
0 3 0
1 2 3 4 5 6 7
PERSONNEL DATA MODULE
PDM
CONTROL RECORD
OPTIONAL
INPUT PDM-01
Run Name
D O C U M E N T
8 9 10 11 12 13 14 15
Run Date
J U N E 7 7
16 17 18 19 20 21 22 23
Lines Per Page
24 25
Institution Name
N C H E M S U
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
List All Input? (Y/N)
Y
56
Fund Records Present? (Y/N)
Y
57
Use Qualified Names? (Y/N)
58
Units Parameter Identifier (PID)
C R E D I T . H O U R S
59 60 61 62 63 64 65 66 67 68 69 70
Convert UPDT CID? (Y/N)
71
Activity Units Distribution Control (C/S)
72
qualifier name on "UEDT" records from SIM

reports and RRPM formatted data. The following is a description of the key control card fields of the PDM3 control card:

RRPM "DISC" Records—Selects the output of names for each discipline in which instructional activities occurred.

RRPM "PROD" Records—Selects the output of productivity ratio (average credit hours taught by an FTE faculty member in each discipline/course level).

RRPM "RMIX" Records—Selects the output of rank-mix records showing the distribution of FTE faculty among academic ranks for each discipline/course level.

RRPM "FSAL" Records—Selects the output of average salary data for each discipline/faculty rank.

Which Activity for RRPM—This field selects the activity code ("INST" in figure 25) for which the above parameters are to be computed.

PDM Reports

PDM produces a set of reports similar to the Student Data Module. The reports document any errors encountered in editing the data and show the results of computations. Figure 32 illustrates a "Report by Person-Type by Person" that shows, for each faculty rank, a distribution of faculty members' FTE and salaries among their activities. This report documents the same distribution of faculty that was illustrated in figure 25 step (A). Figure 33 shows a "Consumption Report" documenting the faculty time and salaries related to each activity. This report is also

Figure 31
Other PDM Control Cards

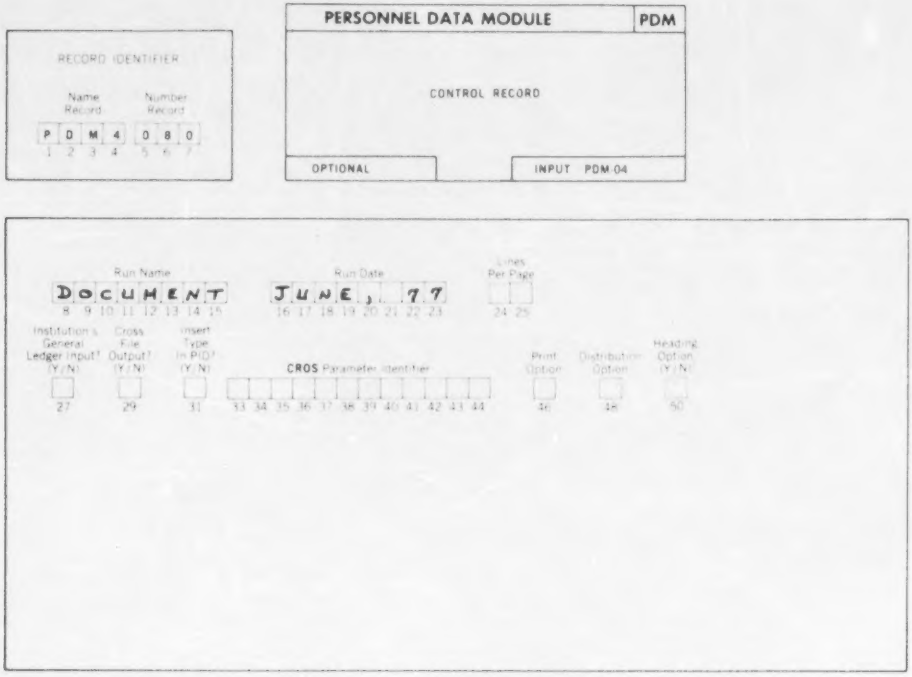


Figure 31 (Continued)
Other PDM Control Cards

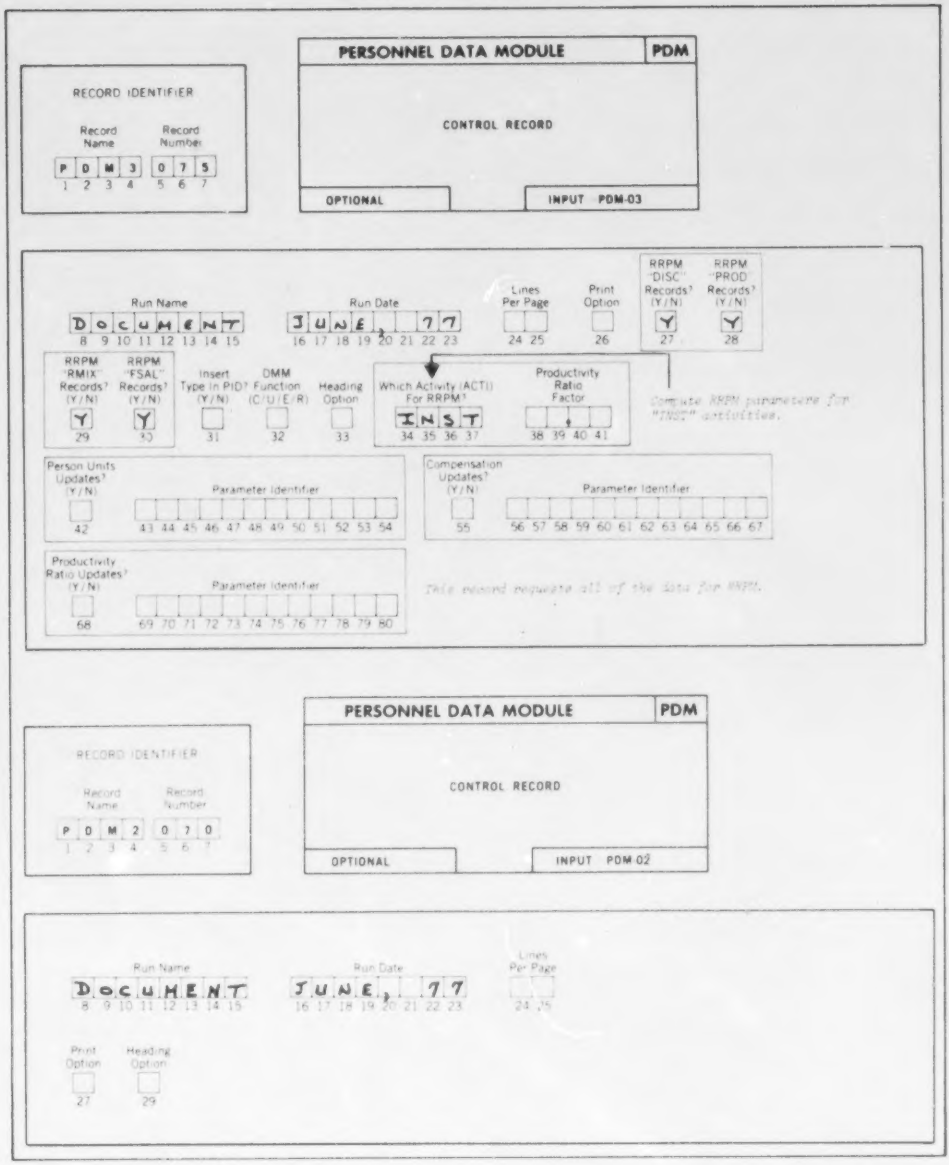
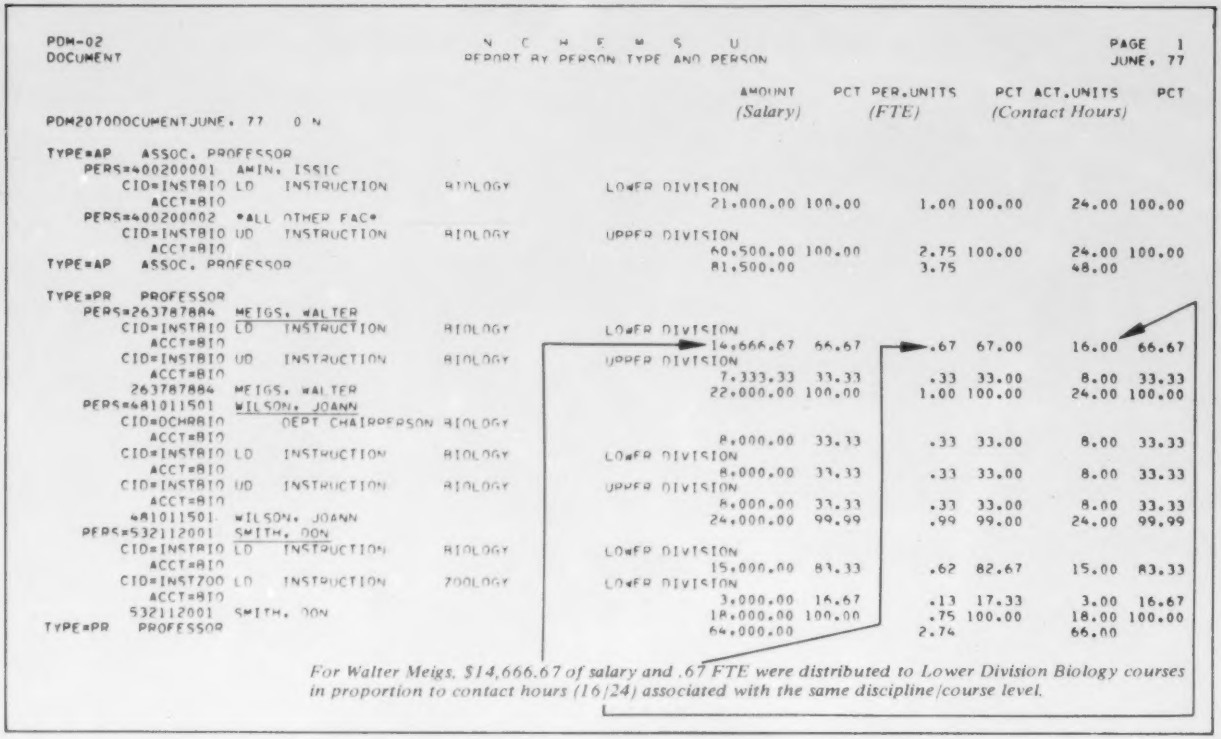


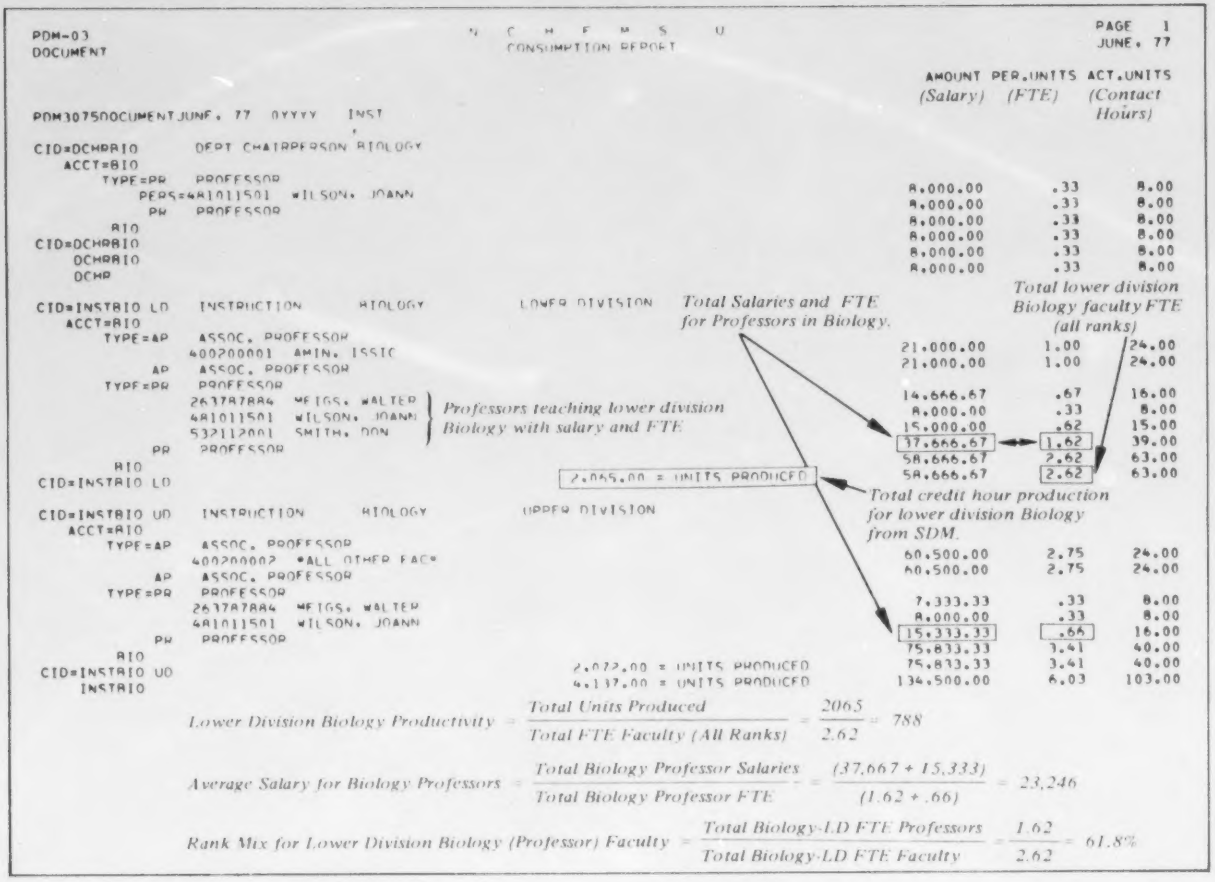
Figure 32
PDM Report by Person



```
PDM-02                                    N  C  H  E  M  S  U                                  PAGE   1
DOCUMENT                          REPORT BY PERSON TYPE AND PERSON                            JUNE, 77

                                                                    AMOUNT      PCT PER.UNITS      PCT ACT.UNITS      PCT
                                                                  (Salary)        (FTE)          (Contact Hours)

PDM207DOCUMENTJUNE, 77   0 N

TYPE=AP   ASSOC. PROFESSOR
    PERS=400200001  AMIN, ISSIC
        CID=INSTBIO LD   INSTRUCTION        BIOLOGY        LOWER DIVISION
          ACCT=BIO                                          21,000.00 100.00      1.00 100.00      24.00 100.00
    PERS=400200002  *ALL OTHER FAC*
        CID=INSTBIO UD   INSTRUCTION        BIOLOGY        UPPER DIVISION
          ACCT=BIO                                          60,500.00 100.00      2.75 100.00      24.00 100.00
TYPE=AP   ASSOC. PROFESSOR                                  81,500.00             3.75             48.00

TYPE=PR   PROFESSOR
    PERS=263787884  MEIGS, WALTER
        CID=INSTBIO LD   INSTRUCTION        BIOLOGY        LOWER DIVISION
          ACCT=BIO                                          14,666.67  66.67      .67  67.00       16.00  66.67
        CID=INSTBIO UD   INSTRUCTION        BIOLOGY        UPPER DIVISION
          ACCT=BIO                                           7,333.33  33.33      .33  33.00        8.00  33.33
         263787884  MEIGS, WALTER                         22,000.00 100.00      1.00 100.00       24.00 100.00
    PERS=4A1011501  WILSON, JOANN
        CID=DCHRBIO       DEPT CHAIRPERSON BIOLOGY
          ACCT=BIO                                           8,000.00  33.33      .33  33.00        8.00  33.33
        CID=INSTBIO LD   INSTRUCTION        BIOLOGY        LOWER DIVISION
          ACCT=BIO                                           8,000.00  33.33      .33  33.00        8.00  33.33
        CID=INSTBIO UD   INSTRUCTION        BIOLOGY        UPPER DIVISION
          ACCT=BIO                                           8,000.00  33.33      .33  33.00        8.00  33.33
         4A1011501  WILSON, JOANN                         24,000.00  99.99      .99  99.00       24.00  99.99
    PERS=532112001  SMITH, DON
        CID=INSTBIO LD   INSTRUCTION        BIOLOGY        LOWER DIVISION
          ACCT=BIO                                          15,000.00  83.33      .62  82.67       15.00  83.33
        CID=INST700 LD   INSTRUCTION        ZOOLOGY        LOWER DIVISION
          ACCT=BIO                                           3,000.00  16.67      .13  17.33        3.00  16.67
         532112001  SMITH, DON                            18,000.00 100.00      .75 100.00       18.00 100.00
TYPE=PR   PROFESSOR                                         64,000.00             2.74             66.00
```

For Walter Meigs, $14,666.67 of salary and .67 FTE were distributed to Lower Division Biology courses in proportion to contact hours (16/24) associated with the same discipline/course level.

Figure 33
PDM Consumption Report



```
PDM=03                                  N  C  H  F  M  S  U                    PAGE  1
DOCUMENT                                CONSUMPTION REPORT                     JUNE, 77

                                                                  AMOUNT PER.UNITS ACT.UNITS
                                                                  (Salary)  (FTE)  (Contact
                                                                                    Hours)
PDM307500CUMENTJUNE, 77  0YYYY   INST

CID=DCHBBIO      DEPT CHAIRPERSON BIOLOGY
   ACCT=BIO
      TYPE=PR    PROFESSOR
         PERS=4B1011501  WILSON, JOANN                            8,000.00    .33     8.00
           PR    PROFESSOR                                        8,000.00    .33     8.00
                                                                  8,000.00    .33     8.00
        BIO                                                       8,000.00    .33     8.00
CID=DCHBBIO                                                       8,000.00    .33     8.00
    DCHBBIO                                                       8,000.00    .33     8.00
    DCHB

CID=INSTBIO LD   INSTRUCTION      BIOLOGY        LOWER DIVISION
   ACCT=BIO
      TYPE=AP    ASSOC, PROFESSOR
                 400200001  AMIN, ISSIC                          21,000.00   1.00    24.00
           AP    ASSOC, PROFESSOR                                21,000.00   1.00    24.00
      TYPE=PR    PROFESSOR
                 263787884  WEIGS, WALTER                        14,666.67    .67    16.00
                 4B1011501  WILSON, JOANN                         8,000.00    .33     8.00
                 532112001  SMITH, DON                           15,000.00    .62    15.00
           PR    PROFESSOR                                       37,666.67   1.62    39.00
        BIO                                                       58,666.67   2.62    63.00
CID=INSTBIO LD                  2,065.00 = UNITS PRODUCED         58,666.67   2.62    63.00

CID=INSTBIO UD   INSTRUCTION      BIOLOGY        UPPER DIVISION
   ACCT=BIO
      TYPE=AP    ASSOC, PROFESSOR
                 400200002  *ALL OTHER FAC*                      60,500.00   2.75    24.00
           AP    ASSOC, PROFESSOR                                60,500.00   2.75    24.00
      TYPE=PR    PROFESSOR
                 263787884  WEIGS, WALTER                         7,333.33    .33     8.00
                 4B1011501  WILSON, JOANN                         8,000.00    .33     8.00
                                                                  15,333.33    .66    16.00
           PR    PROFESSOR                                       75,833.33   3.41    40.00
        BIO                                                       75,833.33   3.41    40.00
CID=INSTBIO UD                  2,072.00 = UNITS PRODUCED        134,500.00   6.03   103.00
    INSTBIO                     4,137.00 = UNITS PRODUCED
```

Total Salaries and FTE for Professors in Biology.

Professors teaching lower division Biology with salary and FTE

Total lower division Biology faculty FTE (all ranks)

Total credit hour production for lower division Biology from SDM.

$$\text{Lower Division Biology Productivity} = \frac{\text{Total Units Produced}}{\text{Total FTE Faculty (All Ranks)}} = \frac{2065}{2.62} = 788$$

$$\text{Average Salary for Biology Professors} = \frac{\text{Total Biology Professor Salaries}}{\text{Total Biology Professor FTE}} = \frac{(37{,}667 + 15{,}333)}{(1.62 + .66)} = 23{,}246$$

$$\text{Rank Mix for Lower Division Biology (Professor) Faculty} = \frac{\text{Total Biology-LD FTE Professors}}{\text{Total Biology-LD FTE Faculty}} = \frac{1.62}{2.62} = 61.8\%$$

similar to figure 25, as it summarizes faculty FTE and salary for each column or activity in the figure. This report shows the data used in computing productivity, rank mix, and average salaries. The RRPM formatted data are shown in figure 34. Figure 35 illustrates a "Contribution Report" where each funding account or department is divided among the activities it supports. This report is useful in reconciliation. It shows the instructional activities for the department that are included in the computation of RRPM parameters, and it documents the FTE and salary for faculty that are not included (for example, department chairman) or faculty who leave the department to teach in other disciplines.

OTHER RRPM INPUT DATA

The previous two sections outlined the use of software to prepare student and faculty input to RRPM. There are additional parameters that must be prepared for input to the model. These data must be prepared either manually or by software designed by the campus using the model. The data include: (1) RRPM definitional data, (2) nonfaculty expense data for each discipline, and (3) estimating equations for noninstructional activities (such as libraries and financial aid). Where the "long method" for calculating FTE faculty in disciplines is to be used, additional input parameters, described in the appendix, must be prepared rather than using the Personnel Data Module software.

RRPM definitional data are necessary to describe the campus organizational characteristics to the model. The Definition Record, shown in figure 32, is used to define the name and coding abbreviation for each class of data, including: organizational hierarchy, course levels, student levels, instructional types,* faculty ranks, staff categories, and discipline expense types. Figure 36 also illustrates the Definition Records for each of these elements using the example provided in figures 13 and 27. The remaining definitional data are the names for each instructional department and school/college. Figure 37 shows sample organizational structure. This three-tiered organizational scheme is represented in the model by first describing the name of each organizational tier as "organizational hierarchy" on a Definition Record. The first tier might be a division, school, or college as in the example. The second tier in the diagram is a department, while the third tier is a discipline. All of the data for input to the model must be collected at the third tier, or in this case, the discipline level.

*This definition is needed only if *long method* faculty data are collected.

Figure 34
RRPM Input Data

```
PROD  DBIO L007R817
RMIX  DBIO LD  RP03R2
RMIX  DBIO LD  PR061R
PROD  DBIO UD0A0762
RMIX  DBIO UD  AP0806
RMIX  DBIO UD  PR0194
DISC  DBIO BIOLOGY
FSAL  DBIO AP21733
FSAL  DBIO PR23246
RMIX  D700 LD  PR1000
DISC  D700 ZOOLOGY
FSAL  D700 PR23077
```

RRPM Productivity Data for the "BIO" (Biology) discipline and "LD" (Lower Division) course level is 788.17 credit hours per FTE faculty member.

RRPM Rank Mix Data for the "BIO" (Biology) discipline and "LD" (Lower Division) course level is 61.8 percent of FTE faculty ranked "PR" (Professor).

RRPM Faculty Average Salary Data for the "BIO" (Biology) discipline and rank "PR" (Professor) is $23,246 per FTE faculty member.

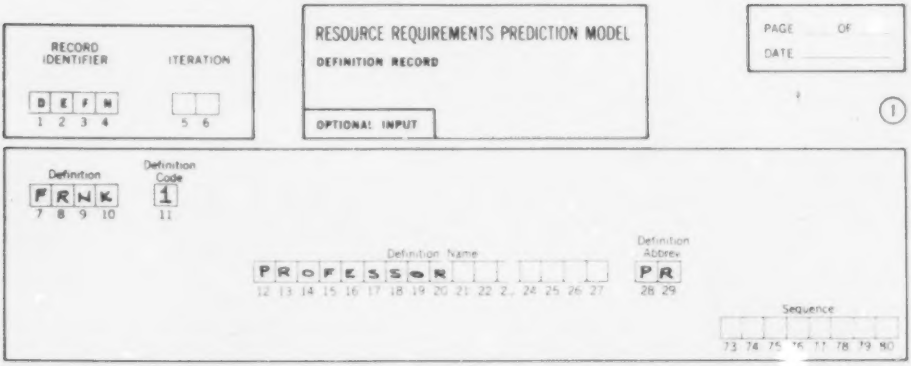
Figure 35
PDM Contribution Report

PDM-04 N C M F W S U — CONTRIBUTION REPORT — PAGE 2
DOCUMENT — JUNE, 76

For the funding account "BIO," these are the activities supported.

		AMOUNT	PER.UNITS	ACT.UNITS
ACCT=BIO				
CID=DCHRBIO	DEPT CHAIRPERSON BIOLOGY			
TYPE=PR	PROFESSOR			
PERS=481011501	WILSON, JOANN	8,000.00	.33	8.00
DCHRBIO		8,000.00	.33	8.00
CID=INSTBIO LD	INSTRUCTION BIOLOGY LOWER DIVISION			
TYPE=AP	ASSOC. PROFESSOR			
PERS=400200001	AMIN, ISSIC	21,000.00	1.00	24.00
TYPE=PR	PROFESSOR			
PERS=263787886	HEIGS, WALTER	14,666.67	.67	16.00
481011501	WILSON, JOANN	8,000.00	.33	8.00
532112001	SMITH, DON	15,000.00	.62	15.00
PR	PROFESSOR	37,666.67	1.62	39.00
INSTBIO LD		58,666.67	2.62	63.00
CID=INSTBIO UD	INSTRUCTION BIOLOGY UPPER DIVISION			
TYPE=AP	ASSOC. PROFESSOR			
PERS=400200002	*ALL OTHER FAC*	60,500.00	2.75	24.00
TYPE=PR	PROFESSOR			
PERS=263787886	HEIGS, WALTER	7,333.33	.33	8.00
481011501	WILSON, JOANN	8,000.00	.33	8.00
PR	PROFESSOR	15,333.33	.66	16.00
INSTBIO UD		75,833.33	3.41	40.00
CID=INSTZOO LD	INSTRUCTION ZOOLOGY LOWER DIVISION			
TYPE=PR	PROFESSOR			
PERS=532112001	SMITH, DON	3,000.00	.13	3.00
INSTZOO LD		3,000.00	.13	3.00
ACCT=BIO		145,500.00	6.49	114.00

Figure 36
Coding RRPM Definitional Data



This input provides the system with user-supplied names and abbreviations of selected data elements. These labels are used by the system for linking and identifying data elements for either calculating and/or reporting. If the user chooses not to redefine certain data elements, the system will use the definition codes displayed below for the DEFINITION ABBREV.

	DATA	DEFINITION	CODE	MAXIMUM NUMBER
1.	Organizational Hierarchy (Default: 1 = DISCIPLINE 2 = DEPARTMENT, 3 = SCHOOL/COLLEGE)	ORGN	1	3
2.	Course Levels*	CRLV	1	7
3.	Student Levels*	STLV	1	7
4.	Instruction Types	INST	1	5
5.	Faculty Ranks	FRNK	1	6
6.	Staff Categories	SCAT	1	4
7.	Discipline Expense Types	EXPN	1	7

*Optional output of TCLM Generator

Data Class	Data Element Name	Abbreviation
Organization Hierarchy (ORGN)	DISCIPLINE	DI
	DEPARTMENT	DE
	SCHOOL/COLLEGE	SC
Course Levels (CRLV)	LOWER DIVISION	LD
	UPPER DIVISION	UD
Student Levels (STLV)	LOWER LEVEL	20
	UPPER LEVEL	30
	GRADUATE LEVEL	50
Faculty Ranks (FRNK)	PROFESSOR	PR
	ASSOCIATE PROFESSOR	AP
	ASSISTANT PROFESSOR	TP
Staff Categories (SCAT)	LAB ASSISTANT	LA
	SECRETARIAL	SE
	STUDENT ASSISTANT	SA
Expense Types (EXPN)	EQUIPMENT	EQ
	SUPPLIES	SU
	TRAVEL	TR
	TELEPHONE	TE

Figure 37
Example Organization Scheme

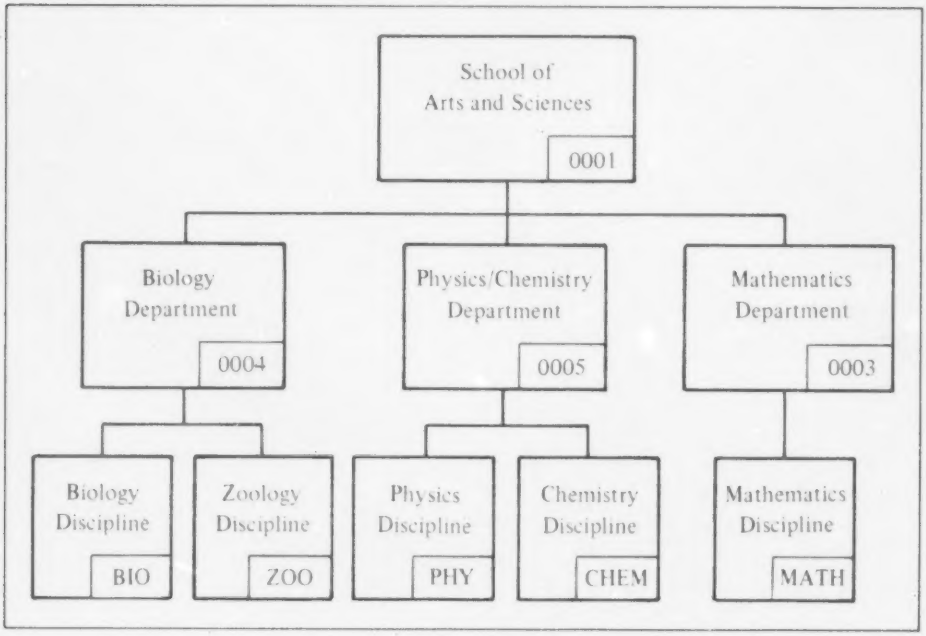
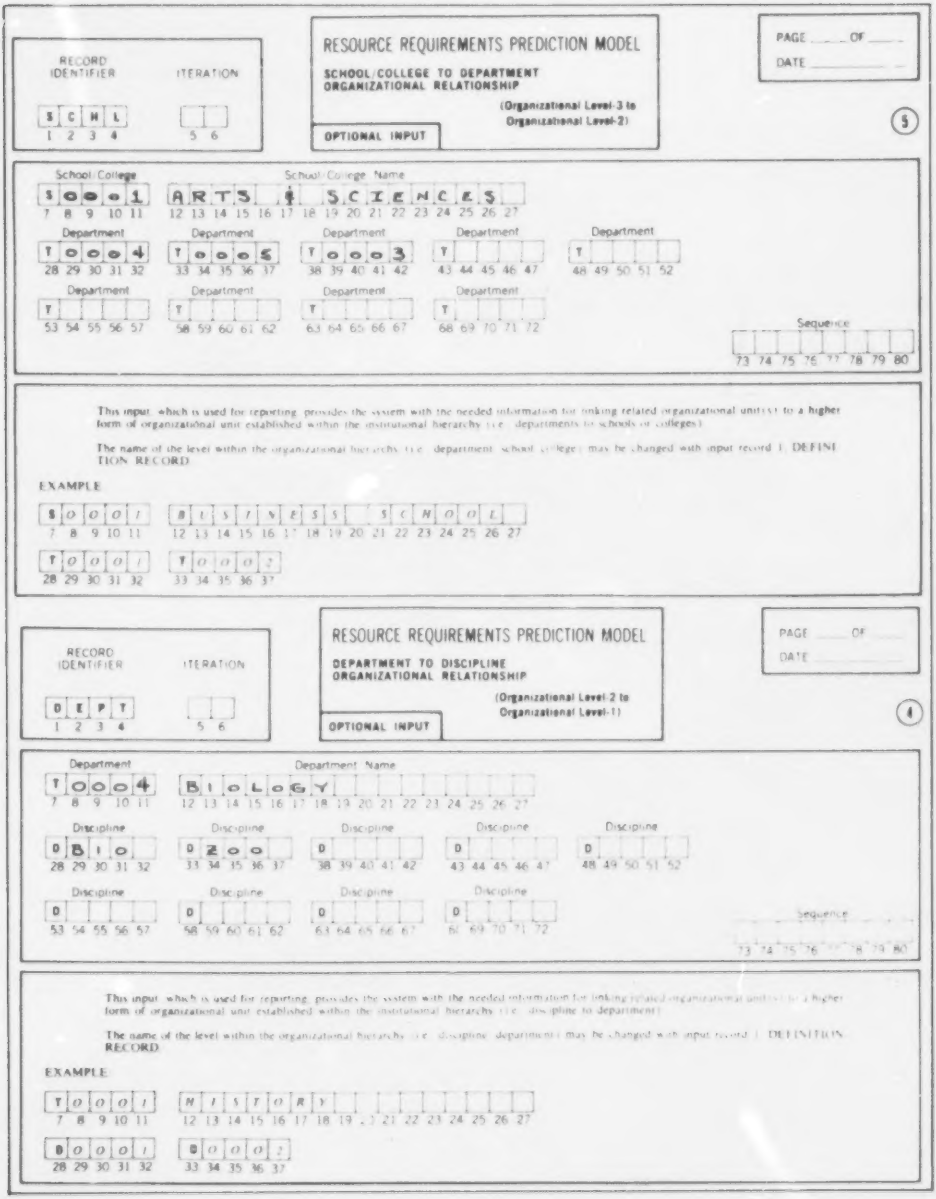


Figure 38 illustrates the use of the School/College to Department Organizational Relationship Record and the Department to Discipline Organizational Relationship Record to define these organizational relationships using the school/department/discipline codes shown in figure 37.

The nonfaculty expenses in each discipline include the other line-item expenses that appear in a departmental budget such as secretaries, lab assistants, supplies, equipment, telephone, and travel. These data are provided as input to the model in the form of linear estimating equations for each expense type within each discipline. Formulas for each expense enable RRPM to estimate variations in expenses as volume of departmental activity (credit hours taught, FTE faculty teaching, and so forth) changes. Nonfaculty expense formulas are further divided into staff categories and other discipline operating expenses.

Figure 38
Defining Organizational Relationships


RECORD IDENTIFIER
S C H L
1 2 3 4
ITERATION
5 6
RESOURCE REQUIREMENTS PREDICTION MODEL
SCHOOL/COLLEGE TO DEPARTMENT ORGANIZATIONAL RELATIONSHIP
(Organizational Level-3 to Organizational Level-2)
OPTIONAL INPUT
PAGE ____ OF ____
DATE ____
5
School/College
S 0 0 0 1
7 8 9 10 11
School/College Name
A R T S & S C I E N C E S
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Department
T 0 0 0 4
28 29 30 31 32
T 0 0 0 5
33 34 35 36 37
T 0 0 0 3
38 39 40 41 42
43 44 45 46 47
48 49 50 51 52
53 54 55 56 57
58 59 60 61 62
63 64 65 66 67
68 69 70 71 72
Sequence
73 74 75 76 77 78 79 80
This input, which is used for reporting, provides the system with the needed information for linking related organizational unit(s) to a higher form of organizational unit established within the institutional hierarchy (i.e., departments to schools or colleges).
The name of the level within the organizational hierarchy (i.e., department, school, college) may be changed with input record 1, DEFINITION RECORD.
EXAMPLE
S 0 0 0 1
B I S I N E S S S C H O O L
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
T 0 0 0 1
28 29 30 31 32
T 0 0 0 2
33 34 35 36 37
RECORD IDENTIFIER
D E P T
1 2 3 4
ITERATION
5 6
RESOURCE REQUIREMENTS PREDICTION MODEL
DEPARTMENT TO DISCIPLINE ORGANIZATIONAL RELATIONSHIP
(Organizational Level-2 to Organizational Level-1)
OPTIONAL INPUT
PAGE ____ OF ____
DATE ____
4
Department
T 0 0 0 4
7 8 9 10 11
Department Name
B I O L O G Y
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Discipline
D B I O
28 29 30 31 32
D Z O O
33 34 35 36 37
38 39 40 41 42
43 44 45 46 47
48 49 50 51 52
53 54 55 56 57
58 59 60 61 62
63 64 65 66 67
68 69 70 71 72
Sequence
73 74 75 76 77 78 79 80
This input, which is used for reporting, provides the system with the needed information for linking related organizational unit(s) to a higher form of organizational unit established within the institutional hierarchy (i.e., discipline to department).
The name of the level within the organizational hierarchy (i.e., discipline, department) may be changed with input record 1, DEFINITION RECORD.
EXAMPLE
T 0 0 0 1
7 8 9 10 11
H I S T O R Y
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
D 0 0 0 1
28 29 30 31 32
D 0 0 0 2
33 34 35 36 37

An estimating equation must be developed for *each* staff category (such as secretaries and lab assistants) in each discipline. The equation must be in the form:

$$\text{Staff Expense} = (K + xA + yB + zC) * D$$

where, for each staff category:

K = the fixed or constant number of FTE staff of this category in the discipline;
A = the number of FTE faculty in this discipline derived by the model;
B = the number of student credit hours in this discipline derived by the model;
C = the number of FTE chairmen in this discipline;
D = the average annual salary for this type of staff in this discipline;
x = a historical FTE staff to FTE faculty coefficient;
y = a historical FTE staff to student credit hour coefficient;
z = a historical FTE staff to FTE chairmen coefficient.

An example of secretarial staff might be that the Biology discipline has historically had one secretary and an additional one-fourth secretary for each FTE faculty member. If the average salary for a secretary is $8,500 per year, the previous formula would appear as:

$$\begin{aligned}\text{Secretary Staff Expense} &= (1 + .25A + 0.0B + 0.0C) * \$8{,}500 \\ &= (1 + .25A) * \$8{,}500\end{aligned}$$

As the model estimates the number of FTE faculty from student credit hour demand in each discipline, the formula above is used to estimate the FTE secretarial staff and their associated expense. Similar formulas are developed for all staff categories in each discipline.

The linear equations must be derived by using historical data from the campus (or by comparing with other campuses through exchange of data) and/or statistical analysis techniques such as least squares, linear regression, or multiple regression.

For a validation run, the current staff FTE can be entered as a constant. For prediction runs it is possible to leave the staff FTE as a constant for each iteration, reenter only changes to staff FTE for each iteration, or develop a formula.

An estimating equation must be developed for *each* "other" expense type such as supplies, equipment, travel, and telephone. This equation must be of the form:

$$\text{Expense} = K + uA + vB + wC + xD + yE + zF$$

where, for each type of expense:

K = the fixed or constant cost for this expense type in this discipline;
A = the number of FTE faculty in this discipline derived by the model;
B = the number of FTE staff in this discipline derived by the model;
C = the number of FTE chairmen in this discipline derived by the model;
D = the number of student credit hours in this discipline derived by the model;
E = the faculty salaries in this discipline derived by the model;
F = the staff salaries in this discipline derived by the model;
u = a historical expense to FTE faculty coefficient;
v = a historical expense to FTE staff coefficient;
w = a historical expense to FTE chairmen coefficient;
x = a historical expense to student credit hour coefficient;
y = a historical expense to faculty salaries coefficient;
z = a historical expense to staff salaries coefficient.

An example of telephone expenses in the Biology discipline might be that annually the cost of telephones is $340 and each faculty member is allowed $50 per FTE faculty member annually for long-distance professional phone calls. This would be represented as follows, where all coefficients except that associated with FTE faculty are zero:

Telephone Expense = $340 + $50(A)

Figure 39 shows the previous two formulas developed for secretaries and telephone expenses prepared as input to RRPM.

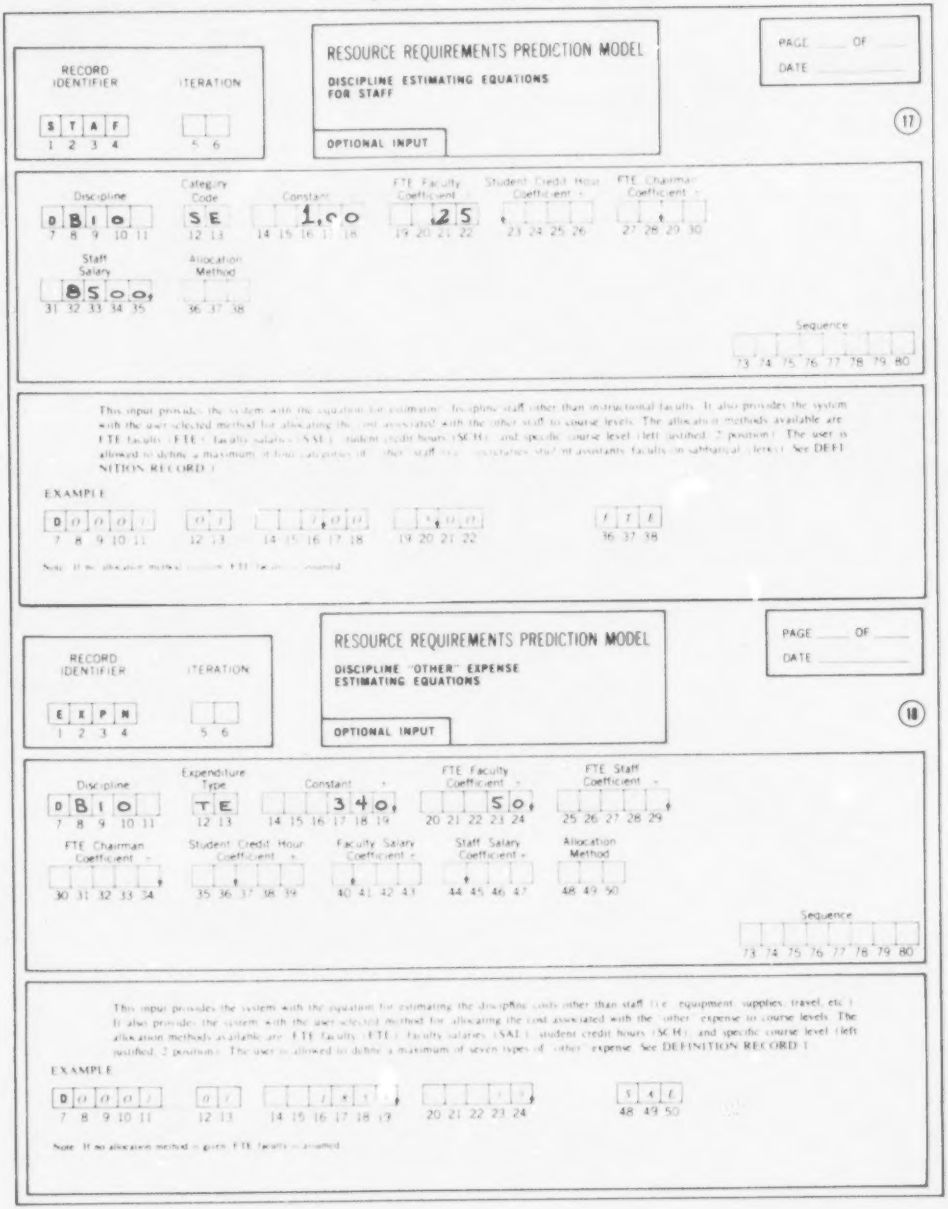
RRPM OUTPUT AND VALIDATION

Report Interpretation

There are four separate RRPM reports that include:

1. **Organizational Budget:** A report showing estimated resources and costs for each organizational unit. It is formatted as a line-item budget for each discipline, with summaries for departments and schools.
2. **Program Budget:** When cost data have been prorated to each student major, a program budget is produced to list the estimated program cost and the average annual cost per student in each major.
3. **Institutional Summary:** A summary report showing the total annual cost of instruction and any other activities for which noninstructional estimating equations were provided.

Figure 39
Example Estimating Equations



RECORD IDENTIFIER: S T A F (1 2 3 4) — ITERATION (5 6)

RESOURCE REQUIREMENTS PREDICTION MODEL

DISCIPLINE ESTIMATING EQUATIONS FOR STAFF

OPTIONAL INPUT

PAGE ____ OF ____

DATE ____

(17)

Discipline (7 8 9 10 11): D B I O

Category Code (12 13): S E

Constant (14 15 16 17 18): 1,0 0

FTE Faculty Coefficient (19 20 21 22): .2 5

Student Credit Hour Coefficient (23 24 25 26):

FTE Chairman Coefficient (27 28 29 30):

Staff Salary (31 32 33 34 35): 8 5 0 0,

Allocation Method (36 37 38):

Sequence (73 74 75 76 77 78 79 80):

This input provides the system with the equation for estimating discipline staff (other than instructional faculty). It also provides the system with the user-selected method for allocating the cost associated with the other staff to course levels. The allocation methods available are: FTE faculty (FTE), faculty salaries (SALF), student credit hours (SCH), and specific course level (left justified, 2 positions). The user is allowed to define a maximum of four categories of other staff (e.g., secretaries, staff assistants, faculty on sabbatical, clerks). See DEFINITION RECORD 1.

EXAMPLE

D O O O 1 (7 8 9 10 11) — O 2 (12 13) — 7 0 0 (14 15 16 17 18) — 5 0 0 (19 20 21 22) — F T E (36 37 38)

Note: If no allocation method is given, FTE faculty is assumed.

RECORD IDENTIFIER: E X P N (1 2 3 4) — ITERATION (5 6)

RESOURCE REQUIREMENTS PREDICTION MODEL

DISCIPLINE "OTHER" EXPENSE ESTIMATING EQUATIONS

OPTIONAL INPUT

PAGE ____ OF ____

DATE ____

(18)

Discipline (7 8 9 10 11): D B I O

Expenditure Type (12 13): T E

Constant (14 15 16 17 18 19): 3 4 0,

FTE Faculty Coefficient (20 21 22 23 24): 5 0,

FTE Staff Coefficient (25 26 27 28 29):

FTE Chairman Coefficient (30 31 32 33 34):

Student Credit Hour Coefficient (35 36 37 38 39):

Faculty Salary Coefficient (40 41 42 43):

Staff Salary Coefficient (44 45 46 47):

Allocation Method (48 49 50):

Sequence (73 74 75 76 77 78 79 80):

This input provides the system with the equation for estimating the discipline costs other than staff (i.e., equipment, supplies, travel, etc.). It also provides the system with the user-selected method for allocating the cost associated with the "other" expense to course levels. The allocation methods available are: FTE faculty (FTE), faculty salaries (SALF), student credit hours (SCH), and specific course level (left justified, 2 positions). The user is allowed to define a maximum of seven types of "other" expense. See DEFINITION RECORD 1.

EXAMPLE

D O O O 1 (7 8 9 10 11) — O 7 (12 13) — 1 , 5 0 0 (14 15 16 17 18 19) — 2 0 0 (20 21 22 23 24) — S A L (48 49 50)

Note: If no allocation method is given, FTE faculty is assumed.

4. **Formatted File Display:** This is an audit report that provides a formatted list of all RRPM data (both input data and the intermediate results of internal computations). This report is necessary for program debugging or for validation of base-year data and should not be generated each time the model is run.

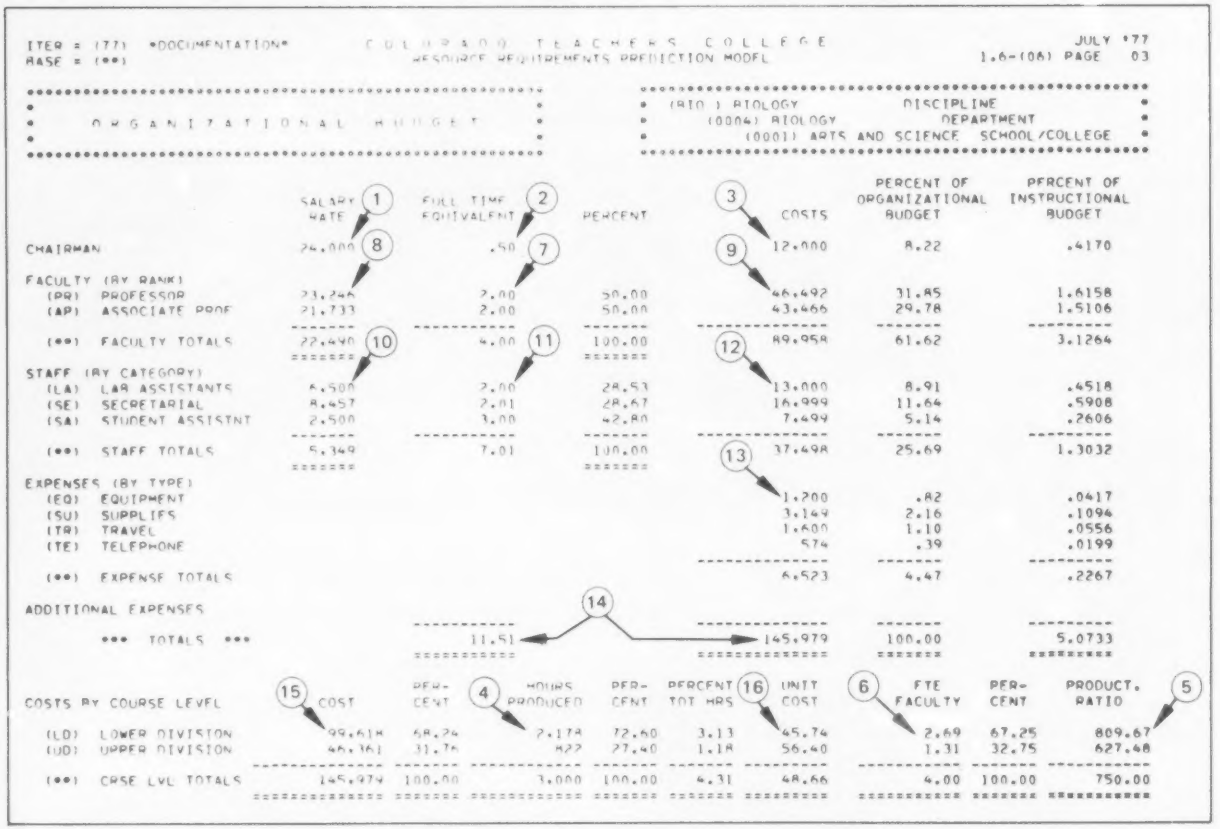
For the Organizational Budget Report, the following is a description of the report items and how they are computed. Figure 40 illustrates the report format.

(1) **Average Chairman's Salary:** This item is input data.
(2) **Chairman FTE:** This item is input data.*
(3) **Total Chairman Cost:** This is the product of (1) and (2).
(4) **Total Hours Produced:** The total credit hours produced by the discipline through lower division and upper division courses. It is the total for the row in the IWLM corresponding to the Biology discipline.
(5) **Productivity Ratio:** This item is input data when short-method data are used. For long method, it is computed by dividing the total credit hours at each course level (4) by the number of FTE faculty (6) at each level.
(6) **FTE Faculty:** For short-method data, this is computed by dividing total credit hours (4) at each course level by the productivity ratio (5). For long method, this is computed using total credit hours (4) at each course level and other long-method input parameters that are described in appendix A but are not listed on the report.
(7) **Faculty FTE by Rank:** After the FTE faculty are computed in (6) for each course level, the total for each level is distributed across faculty ranks using the faculty rank-mix input parameters. The report then shows the total FTE estimated for each rank.
(8) **Faculty Salary Rate:** This item is input data.
(9) **Faculty Cost:** This is the estimated cost for each faculty rank. It is computed using faculty FTE (7) and average salary (8) for each rank.
(10) **Staff Salary Rate:** This item is input as part of staff-estimating equations.
(11) **Staff FTE:** This is computed using the staff-estimating equation for each staff type and other discipline parameters.
(12) **Staff Costs:** This is the product of staff FTE (11) and staff salary rate (10). For example, the equation for student assistants is:

$$\text{Student Assistant FTE} = 1.00 + .50\,(\text{FTE faculty})$$
$$= 1.00 + .50\,(4.00) = 1.00 + 2.00 = 3.00$$

*Department chairmen data are input on RRPM records.

Figure 40
RRPM Organizational Budget Report



ITER = (77) *DOCUMENTATION* COLORADO TEACHERS COLLEGE JULY '77
BASE = (**) RESOURCE REQUIREMENTS PREDICTION MODEL 1.6-(08) PAGE 03

ORGANIZATIONAL BUDGET

(BIO) BIOLOGY DISCIPLINE
(0004) BIOLOGY DEPARTMENT
(0001) ARTS AND SCIENCE SCHOOL/COLLEGE

	SALARY RATE (1)	FULL TIME EQUIVALENT (2)	PERCENT	(3) COSTS	PERCENT OF ORGANIZATIONAL BUDGET	PERCENT OF INSTRUCTIONAL BUDGET
CHAIRMAN	24.000 (8)	.50 (7)		(9) 12.000	8.22	.4170
FACULTY (BY RANK)						
(PR) PROFESSOR	23.246	2.00	50.00	46.492	31.85	1.6158
(AP) ASSOCIATE PROF	21.733	2.00	50.00	43.466	29.78	1.5106
(**) FACULTY TOTALS	22.490 (10)	4.00 (11)	100.00	(12) 89.958	61.62	3.1264
STAFF (BY CATEGORY)						
(LA) LAB ASSISTANTS	6.500	2.00	28.53	13.000	8.91	.4518
(SE) SECRETARIAL	8.457	2.01	28.67	16.999	11.64	.5908
(SA) STUDENT ASSISTNT	2.500	3.00	42.80	7.499	5.14	.2606
(**) STAFF TOTALS	5.349	7.01	100.00	(13) 37.498	25.69	1.3032
EXPENSES (BY TYPE)						
(EQ) EQUIPMENT				1.200	.82	.0417
(SU) SUPPLIES				3.149	2.16	.1094
(TR) TRAVEL				1.600	1.10	.0556
(TE) TELEPHONE				574	.39	.0199
(**) EXPENSE TOTALS				6.523	4.47	.2267
ADDITIONAL EXPENSES						
*** TOTALS ***		(14) 11.51		(14) 145.979	100.00	5.0733

COSTS BY COURSE LEVEL	(15) COST	PER-CENT	(4) HOURS PRODUCED	PER-CENT	PERCENT TOT HRS	(16) UNIT COST	(6) FTE FACULTY	PER-CENT	PRODUCT. RATIO (5)
(LD) LOWER DIVISION	99.618	68.24	2.174	72.60	3.13	45.74	2.69	67.25	809.67
(UD) UPPER DIVISION	46.361	31.75	822	27.40	1.18	56.40	1.31	32.75	627.48
(**) CRSE LVL TOTALS	145.979	100.00	3.000	100.00	4.31	48.66	4.00	100.00	750.00

Student Assistant Cost = ($2500) X (FTE Student Assistants)
= 2500 (3.00)
= $7500

(13) **Expense Costs:** These costs are computed using the other-expense estimating equations and values for discipline parameters such as FTE faculty. For example, the equation for equipment is:

Equipment $ = $200 + $250 (FTE faculty)
= 200 + 250 (4.00)
= 200 + 1000
= $1200

(14) **Total FTE/Costs:** These figures are the total estimated FTE and cost figures for the discipline.

(15) **Cost by Course Level:** This is the total cost (14) distributed to the disciplines' course levels. Each time cost is computed for an item such as chairman, this distribution to course level takes place.

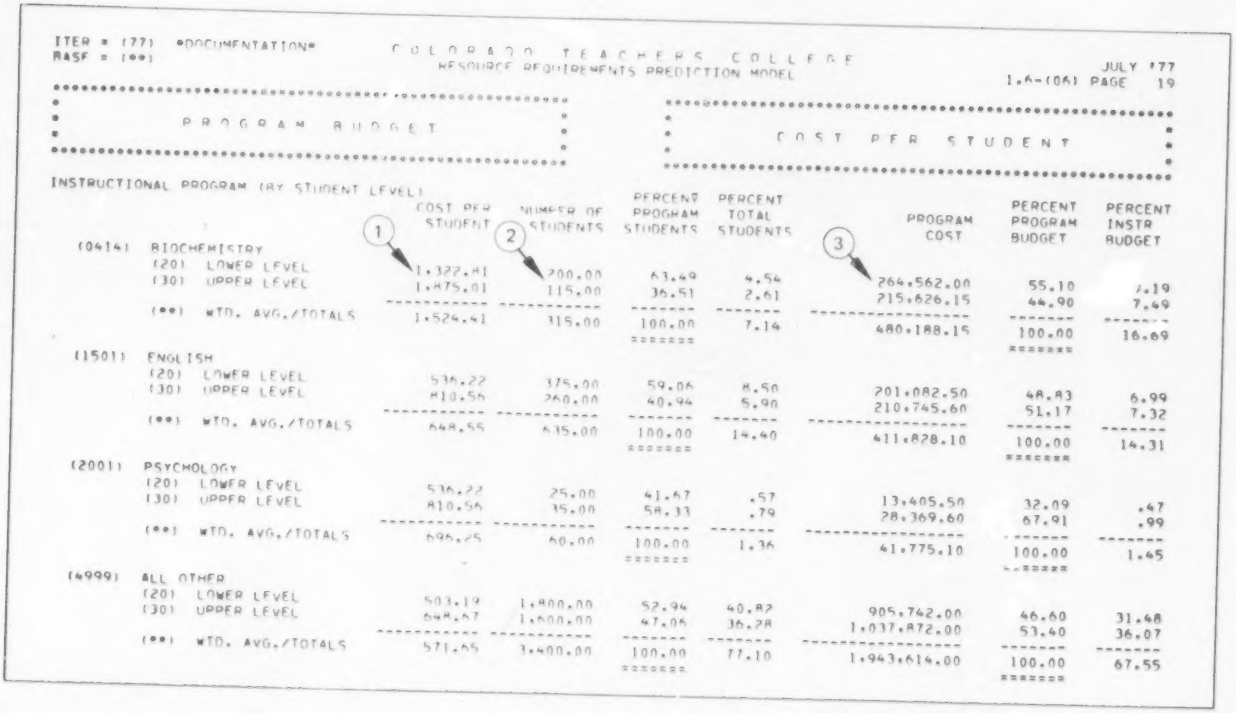
(16) **Unit Cost:** The total cost for each course level (15) is divided by the hours produced (4) giving unit cost. This represents an *average* cost to teach a credit hour for this discipline/level. In a validation it is an average historical cost and is useful for cost comparisons. Other costing methodologies* provide more accurate historical costs. If the sole purpose of a project is to produce historical rather than predictive cost data, a more accurate historical costing methodology is recommended.

The Program Budget Report provides a summary with program enrollments and costs. The major items on the report are described below and illustrated in figure 41.

(1) **Cost Per Student:** The average annual estimated cost per student. This is computed in the following manner:

*See *Historical Full Cost Study Procedures* (Topping 1977).

Figure 41
RRPM Program Budget Report



ITER = (77) *DOCUMENTATION*
BASE = (**)

COLORADO TEACHERS COLLEGE
RESOURCE REQUIREMENTS PREDICTION MODEL

JULY '77
1.6-(06) PAGE 19

PROGRAM BUDGET

COST PER STUDENT

INSTRUCTIONAL PROGRAM (BY STUDENT LEVEL)

		(1) COST PER STUDENT	(2) NUMBER OF STUDENTS	PERCENT PROGRAM STUDENTS	PERCENT TOTAL STUDENTS	(3) PROGRAM COST	PERCENT PROGRAM BUDGET	PERCENT INSTR BUDGET
(0414)	BIOCHEMISTRY							
(20)	LOWER LEVEL	1,322.41	200.00	63.49	4.54	264,562.00	55.10	7.19
(30)	UPPER LEVEL	1,875.01	115.00	36.51	2.61	215,626.15	44.90	5.85
(**)	WTD. AVG./TOTALS	1,524.41	315.00	100.00	7.14	480,188.15	100.00	13.04
(1501)	ENGLISH							
(20)	LOWER LEVEL	536.22	375.00	59.06	8.50	201,082.50	48.83	6.99
(30)	UPPER LEVEL	810.56	260.00	40.94	5.90	210,745.60	51.17	7.32
(**)	WTD. AVG./TOTALS	648.55	635.00	100.00	14.40	411,828.10	100.00	14.31
(2001)	PSYCHOLOGY							
(20)	LOWER LEVEL	536.22	25.00	41.67	.57	13,405.50	32.09	.47
(30)	UPPER LEVEL	810.56	35.00	58.33	.79	28,369.60	67.91	.99
(**)	WTD. AVG./TOTALS	696.25	60.00	100.00	1.36	41,775.10	100.00	1.45
(4999)	ALL OTHER							
(20)	LOWER LEVEL	503.19	1,800.00	52.94	40.82	905,742.00	46.60	31.48
(30)	UPPER LEVEL	698.57	1,600.00	47.06	36.28	1,037,872.00	53.40	36.07
(**)	WTD. AVG./TOTALS	571.55	3,400.00	100.00	77.10	1,943,614.00	100.00	67.55

Discipline/Level		Average Cost/Cr. Hr.	Biochemistry/Lower Level ICLM Data	Contributed Cost
Biology	LD	45.74	6.1	279.01
	UD	56.40	3.0	169.20
•				
•				
•				
Zoology	LD	33.24	6.1	202.76
	UD	39.57	0.0	0.0
				$1,322.81

(2) **Number of Students:** These enrollment projections are input data for the model.

(3) **Program Cost:** This is the total estimated cost to operate the degree program at each student level. The costs included in this total are all costs prorated in the instructional disciplines. It does not include any noninstructional costs, such as library, provided on noninstructional equations.

The Institutional Summary Report provides the estimated costs of noninstructional activities such as libraries. Figure 42 is an example of this report.

(1) **Activity Cost:** The computed cost of each activity using the estimating equation and values of instructional parameters. The constant and coefficients used for each equation are shown in the report. For example, the equation used for Libraries was:

Library Cost = $74,832 + $300 per FTE faculty member
+ $100 per FTE student enrolled.

Validation

The results of cost projections are dependent on the accuracy of data used in the model. A common strategy to ensure the accuracy of a planning model's data is to simulate last year's operation and to compare simulation results with actual operating data. Figure 43 shows that for validation, the historical parameters for the base year are used with the enrollment levels that are known for the same period. The results can be compared with actual operating data for the base year to determine the accuracy of the model and data. Modifications to base-year data

Figure 42
RRPM Institutional Summary Report

ITER = (00) DEFAULT DATA
BASE = (**)

MICRO UNIVERSITY II
RESOURCE REQUIREMENTS PREDICTION MODEL

OCT-1972
1.6-(06) PAGE 33

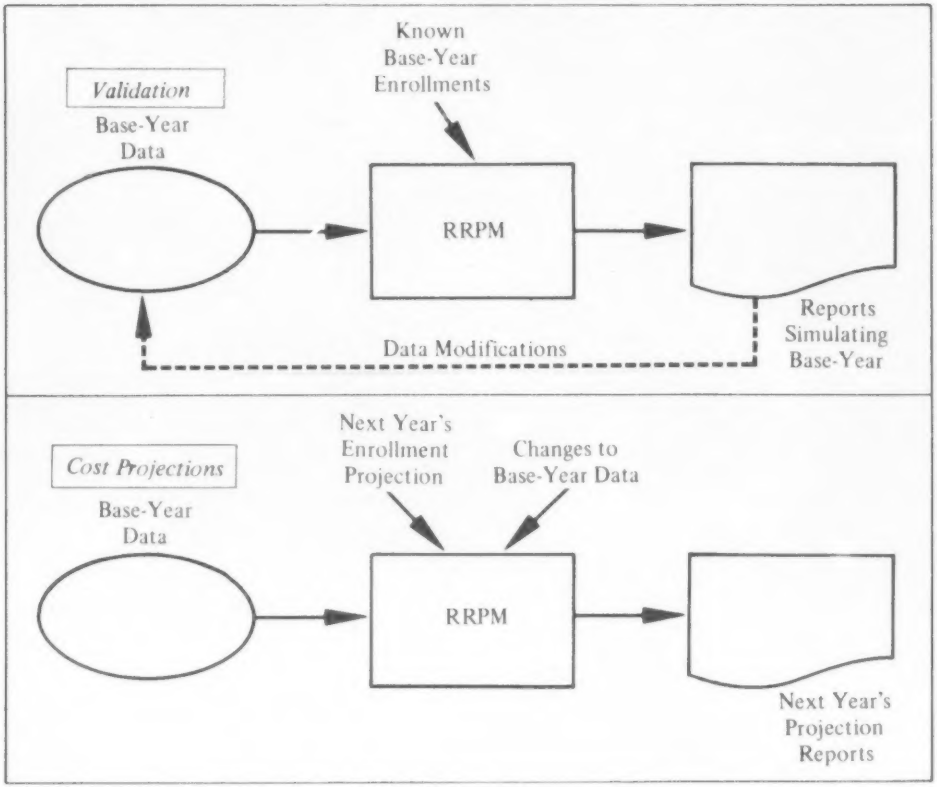
INSTITUTIONAL SUMMARY

ACTIVITY COSTS

ACTIVITY NAME	ACTIVITY COST	ESTIMATING EQUATION COEFFICIENTS						
		CONSTANT	ENROLL.	FACULTY	STAFF	HOURS	FAC-$	STAFF-$ BUDGET
1.00 INSTRUCTION PGM								
1.10 GENERAL ACADEMIC	1,800,078	1,800,078						
1.40 EXTENSION INST.	95,663	82,303	10.00					
SUB-TOTAL	1,895,741							
2.00 ORGANIZED RSRCH								
2.10 INST.& RSRCH CTR	60,194	34,832		300.00				
2.20 IND/PROJ RSRCH	80,490	44,220		500.00				
SUB-TOTAL	140,684							
3.00 PUBLIC SERVICE								
3.10 CONTINUING EDUC.	12,967	12,122		10.00				
3.20 COMMUNITY SERV.	8,882	4,655		50.00				
SUB-TOTAL	21,849							
4.00 ACADEMIC SUPPORT								
4.10 LIBRARIES	233,794	74,832	100.00	300.00				
4.20 MUSEUM-GALLERY	34,914	28,015	2.00	50. 0				
4.40 COMPUTING SUPP.	75,458	53,644	10.00	100. 00				
SUB-TOTAL	344,166							
5.00 STUDENT SERVICE								
5.10 SOC-CUL DEVELOP.	440,250	264,380	100.00	500.00				
5.20 SUPPL. EDUC. SER	60,100	60,100						
5.30 COUNSELING/GUID.	47,560	47,560						
5.40 FINANCIAL AID	32,290	32,290						
5.50 STUDENT SUPP	799,910	666,310	100.00					
SUB-TOTAL	1,380,110							
6.00 INST. SUPPORT								
6.10 EXECUTIVE MGT.	168,878	147,064	10.00	100.00				
6.20 FINANCIAL OPER.	52,549	46,986	1.00	50.00				
6.30 GEN. ADMIN. SERV	244,222	207,712	21.00	100.00				
6.40 LOGISTICAL SERV.	103,615	85,559	10.00	55.55				
6.50 PHYS. PLANT OPER	283,869	271,428		100.00		.210		
6.70 COMMUNITY REL.	75,357	73,176	1.00	10.00				
SUB-TOTAL	928,510							

(1)

Figure 43
Validation and Cost Projections



are sometimes necessary as a result of the validation. Cost projections in the figure use the modified base-year parameters and a set of input parameters for a future time period.

Validation of results can be done throughout the data preparation stages. As data are processed using the Student Data Module (SDM) and Personnel Data Module (PDM), the results can be compared with data from the registrar and personnel office records to ensure accuracy or to reconcile differences.

The SDM registration data are collected early in each term. The data can be processed on a term-by-term basis to compare with registrar reports for the same time or they can be processed once using data for the entire year. The approach selected should be dependent on which reports are available from the student records office. Ultimately, an ICLM must be developed for the entire year. Figures that should be compared with registrar statistics include:

1. From the Contribution Report (by discipline): Total credit hours produced by each discipline and course level.
2. From the Consumption Report (by student major): Total FTE and head-count enrollment for each major and student level.

Where differences exist, a written document should be produced to reconcile them and consider their impact on the resulting ICLM.

The Personnel Data Module (PDM) data include annual FTE and salary data. The software results, therefore, should be compared with annual reports showing faculty workloads. The primary concern with validation of faculty data is to ensure that: (1) all faculty salaries and FTE data were used, (2) correct faculty salaries and FTE data were used, and (3) complete workload assignments are included for each faculty member. For a large campus, it might be advisable to validate a sample of faculty to assess the general reliability of PDM input data.

The PDM software develops RRPM parameters that reflect the "actual" utilization of faculty rather than the more common practice of assuming that because a faculty member is budgeted in a single department he/she has instructional assignments *only* in that department. When workload data show, for example, that faculty member Don Smith has course assignments in two disciplines (see figure 24), PDM software will distribute his FTE and salary across both. PDM (and ultimately RRPM reports) might show total FTE and salary data in disciplines dissimilar to campus operating reports that show budgeted rather than "actual" data. A campus is encouraged to formally reconcile these differences, wherever they exist, for future reference.

PDM report data that might be used in this validation include:

1. From the Report by Person Type and Person: Total salary and FTE for each faculty member. This also shows any people with assignments in more than one department or discipline to aid in reconciliation.
2. Consumption Report: The total salaries and FTE for each discipline/course level. The total FTE and salaries for the discipline should compare with

historical personnel records showing the same. Differences imply that: some faculty data were excluded, incorrect data were coded, or faculty are paid in the discipline and provide services in other areas.

When an RRPM validation report is generated, the same institutional reports should be compared with RRPM results. The following are key items to be checked. Again, written documentation should be developed to reconcile any differences. Where the RRPM input data are incorrect, they should be modified.

1. From the Organizational Budget: Total credit hours for each discipline/level can be compared with registrar statistics. Budget or expenditure reports for a department or discipline should be compared with: faculty FTE by rank, staff FTE, and expenses by type.
2. From the Program Budget: Check to ensure that students actually enrolled in the base year are accurately input by each major/level.

Cost Projections

Once a base-year set of data is processed and validated, a set of historical data is available describing instructional operations. These data can be useful in their own right. They can also serve as the basis for cost simulations. As shown in figure 43, a cost-projection run simulates the effect of changes to base-year data. Such changes may be entered in either of two ways. First, any data item that was input during the base-year run may be altered individually by coding the replacement value on an RRPM input form* and entering the data in a simulation run of the model. For example, to change an ICLM cell, the new value is entered on an ICLM record with the necessary discipline, major, and course/student level codes. A second approach is to use a Blanket Parameter Change* form as RRPM input to alter certain values in base-year data by a percentage amount.

*For input data formats see *Introduction to the Resource Requirements Prediction Model* (Clark, 1973).

Appendix

RRPM—A CONCEPTUAL DESCRIPTION

The Resource Requirements Prediction Model is a generalized software package designed to run on medium-sized computers and most mini-computers. Because it is generalized, every campus receives the same basic set of computer software and "tailors" the model to reflect organizational characteristics through input data.

For those who collect input data and those who will ultimately use the output produced by the model, this section outlines the procedural steps followed in projecting resources. This should give the data collector a general understanding of the input data and model's logic, and may aid in effective interpretation of output reports.

The Induced Course Load Matrix (ICLM) and the closely related Instructional Work Load Matrix (IWLM) are the foundation for instructional resource simulation using the Resource Requirements Prediction Model (RRPM). Both the ICLM and IWLM are examples of what Suslow (1976) calls his "academic matrix." In its simplest form, the ICLM reflects the *average* number of credit hours (or other units such as contact hours, courses, and so forth) that a particular type of student (such as a Math major) takes from each academic discipline or

department (such as English or Sociology). This information might be thought of as the course-taking or "course-consuming" pattern for the student major. For RRPM input, an Induced Course Load Matrix is developed showing the average course-taking patterns for each student major, using student-registration data from historical campus records.

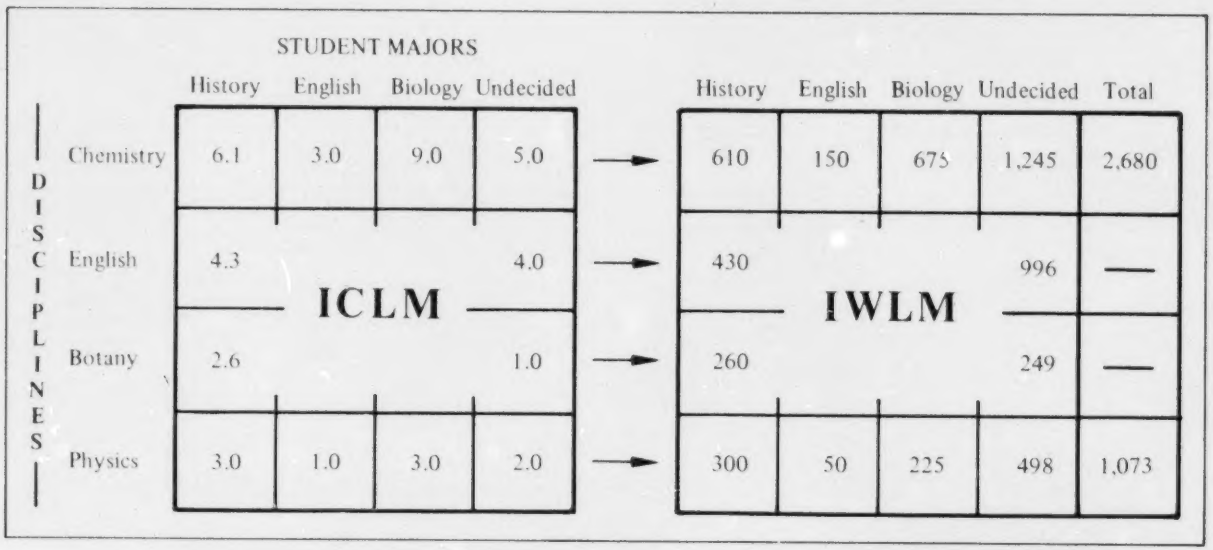
The ICLM shows the course credits earned historically by the *average* student. If the number of students next year for each major is estimated, an Instructional Work Load Matrix (IWLM) can be produced. An IWLM shows the *total* credit hours that are taught to each student major by each academic discipline. An ICLM, for example, would show that the average History major has taken 6.1 credit hours from the Chemistry discipline for some past year. If we estimate the number of History majors enrolled next year to be 100 students, then the IWLM would show the credit hours taught by the Chemistry discipline to History students estimated at 610 (6.1 credit hours per average student times 100 students). Similarly, the enrollment projection for each major would produce an IWLM showing the number of credit hours each academic discipline must teach to students at the estimated enrollment levels.

Figure 44 shows an ICLM and a derived IWLM. Here the ICLM is illustrated as a two-dimensional matrix where each major represents a column in the matrix and each discipline a row. The Instructional Work Load Matrix in the figure is simulated from the ICLM using enrollment projections as follows:

History . . . . . 100 students
English . . . . . 50 students
Biology . . . . . 75 students
Undecided . . . . 249 students

The IWLM also shows the total number of credit hours that must be produced by each discipline to accommodate the enrollment estimates. The fundamental assumptions here are that the enrollment estimates are reasonably accurate and that the ICLM showing average course-taking patterns for students enrolled last year accurately reflects the course-taking patterns for a future period. Neither assumption is absolutely correct. Every campus understands the difficulties in producing accurate enrollment projections. By developing the ICLM for each of the successive years, comparisons will help analyze the stability of an ICLM from year to year. While limited research work has been done on the stability of an ICLM, campuses have found it to depend in varying degrees on:

Figure 44
Academic Matrices



1. The amount of flexibility in a particular major, reflected in the number of electives students are allowed to take;
2. over time, whatever the flexibility, student preferences in the use of electives can be expected to change as they are influenced by political, economic, or social interests; and
3. the availability of course offerings in each discipline. That is, if students generally take art-orientation courses as electives, they may be forced to take course work in another department when all available sections of art orientation are filled.

Figure 45 shows the computations performed by the model to estimate the number of faculty FTE and their associated cost. In that diagram, circles represent input data and the boxes show the results of computations. All the data included in "Definitional Data" are used to describe the characteristics of the campus such as the names of: instructional disciplines, student majors, faculty ranks, levels of students (for example, undergraduate, graduate), levels of courses (such as lower division, upper division), and other similar definitions.

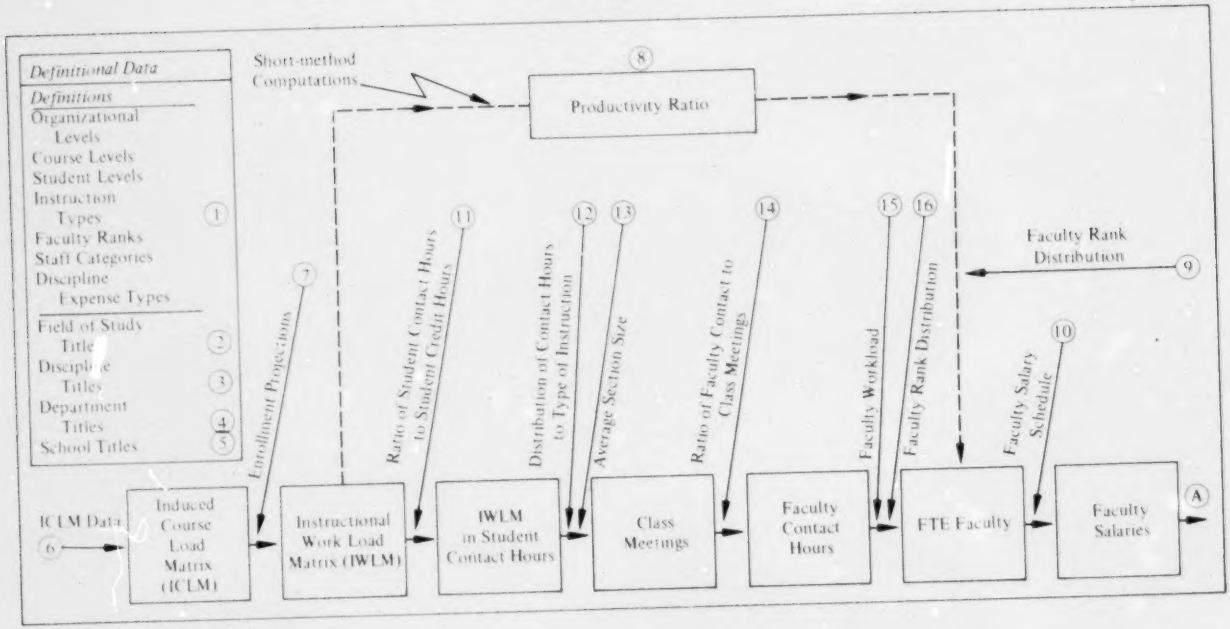
The following discussion outlines the computations and input data used in RRPM. For sake of brevity, the material has been condensed to avoid discussing all the detail possible within the model. For example, in an ICLM a row has been described as an academic discipline. In fact, a row can be further subdivided into course levels within each discipline. A similar discussion to what follows is provided in *An Introduction to the Resource Requirements Prediction Model 1.6,* Technical Report 34A. The *Introduction* document explains all the detail associated with each input item and computation.

An ICLM for a base year* must be provided as input to the model. Figure 45 shows that enrollment projections and ICLM data are combined to produce an Instructional Work Load Matrix. For each row in the IWLM or discipline, the credit hours are summed to provide an estimate of the total credit hours the discipline must teach with the given enrollment mix. This total is then used as the basis for subsequent computations to estimate the number of FTE faculty.

Figure 45 shows two paths from an IWLM to the number of FTE faculty. Each path has a set of computations that arrive at the same result. These paths represent an option available to the model user. The top path is known as the "short

*A base year is a past time period for which RRPM input data are prepared. It then becomes the basis for resource projections in future time periods.

Figure 45
Resource Requirements Prediction Model 1.6
Conceptual Flow



method" of computations while the other is referred to as the "long method." The short method is more frequently used because it requires fewer input data.

Short-Method Computations

A productivity ratio (8) is used to convert the total credit hours taught by a discipline (from the IWLM) into the number of FTE faculty. Productivity for an individual faculty member is:

Σ[(Course Credit Hours) X (Number of Students Enrolled)],
for each course taught during the base year.

When the total number of FTE faculty is estimated for each discipline, the faculty-rank distribution (9) is used to estimate the number of faculty within each academic rank in the discipline. In this way, if historically a discipline has had 50% professors, any new estimate of FTE faculty will include 50% of them as professor.

Long-Method Computations

The long method of computing FTE faculty requires more data as input and provides more detail in calculations of FTE faculty. Input items and computations are described below with references to figure 45:

(11) **Ratio of Student Contact Hours to Student Credit Hours:** This input parameter converts the total discipline credit hours in the IWLM into student contact hours. It makes allowances for disciplines with laboratory courses having no credit but for which there are student contact hours. The ratio is used to produce an IWLM in student contact hours.

(12) **Distribution of Contact Hours to Type of Instruction:** This ratio is multiplied by the total student contact hours taught in each discipline to distribute them to types of instruction such as labs and lectures. The result is the total student contact hours taught in each discipline for labs and other instruction types.

(13) **Average Section Size:** This represents the average number of student contact hours taught per section in each instruction type for a discipline. For example, it might be thought of as the average classroom size (in student contact hours) for laboratories in the Chemistry department. The average is developed using data on laboratories taught last year in the Chemistry department. It translates the total Chemistry laboratory contact hours into

the number of class meetings that must be scheduled.

(14) **Ratio of Faculty Contact to Class Meetings:** This item converts the number of class meetings into faculty contact hours. The ratio allows for special circumstances where an hour of class meeting does not yield an hour of faculty contact, such as with team teaching. The result of this computation is an estimate of the total faculty contact hours required to teach, for example, Chemistry laboratory courses.

(15) **Faculty Workload:** The average contact hour workload for a faculty member teaching each type of instruction in each discipline. For example, this converts the total Chemistry laboratory faculty contact hours into the number of FTE faculty teaching Chemistry labs.

(16) **Faculty Rank Distribution:** Similar to Rank Distribution for the short method, this ratio converts the number of FTE faculty teaching such courses as Chemistry labs into an estimate of FTE faculty *by academic rank* teaching those courses.

Either the long method or short method of computing FTE faculty may be employed for each discipline. Once the FTE faculty are estimated for each rank within each discipline, historical salary data (10) are used to estimate the cost of faculty by rank. The remaining input data items are illustrated in figure 46.

Departmental Chairperson Expenses are estimated using the input describing historical FTE and salary rate (9).

Support Staff Expenses are calculated for each discipline using an equation to estimate staff FTE and a historical salary rate (17). Support staff include any staff (except faculty or chairman) who work directly or indirectly for an academic discipline, such as secretaries, lab assistants, and work/study student help. The equations are linear formulas that express support staff FTE as a constant (fixed FTE) and/or in relation to one or more instructional parameters that include: FTE faculty members, credit hours, or FTE chairman. The equation for secretaries, for example, might be:

Secretary FTE = 1.0 FTE + 1/4 FTE per faculty member

As the number of faculty in the discipline varies, so does the number of secretarial staff, using such a formula. With historical salary data on each type of staff, the model estimates support staff costs.

"Other" Expenses generally include the nonpersonnel expenses in a discipline, such as supplies, equipment, and services. These are usually included in an estimate of resources so that a complete organizational line-item budget can be approximated. Again, the equations are linear formulas that express discipline expenses as a constant (fixed cost) and/or in relation to one or more instructional parameters including: FTE faculty members, FTE support staff, FTE chairman, credit hours, total faculty expense, or total staff expense. An example equation for equipment expense might be:

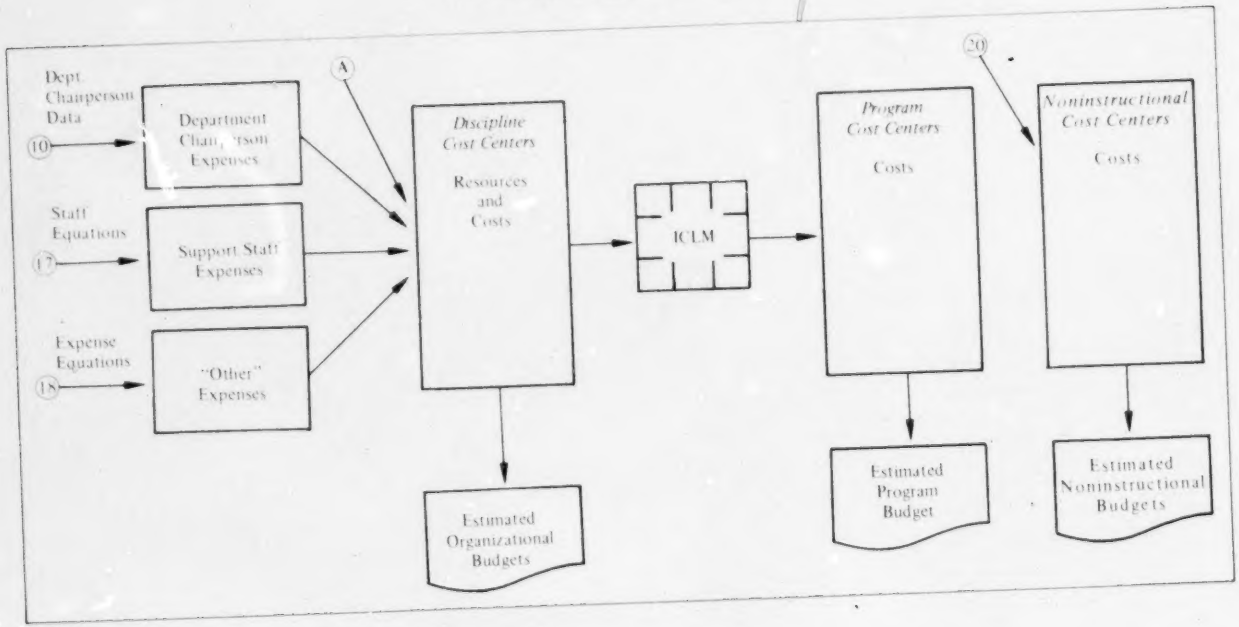
Equipment Expense = \$1000 + \$300 per faculty member
+ \$200 per support staff member.

As shown in figure 46, estimated resources are accumulated for each instructional discipline cost center. An organizational budget report is provided by the model showing the estimates of faculty, staff, and chairman FTE with these and other costs.

Using the estimated discipline costs and the ICLM that was provided as input, the model distributes discipline costs to student majors in proportion to the credit hours taught to each major by a discipline. To illustrate, if the Chemistry discipline teaches 20% of its course credit hours to History majors, 20% of its budget would be prorated to the cost of the History major. When these prorations are accumulated for each major, the total cost of the History program is estimated for the simulated year. A program budget report is produced showing these estimated program costs.

Finally, equations can be developed to estimate the cost of noninstructional activities for the institution such as libraries and financial aid. Here again, these activities must be expressed as a constant expense (fixed cost) or in linear relation to instructional parameters estimated in the model that include: student enrollments, student credit hours, FTE faculty, FTE support staff, total faculty expense, total staff expense, or total instructional budget.

Figure 46
Resource Requirements Prediction Model 1.6
Conceptual Flow (Continued)



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